A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

The SCIENCE COUNSELOR

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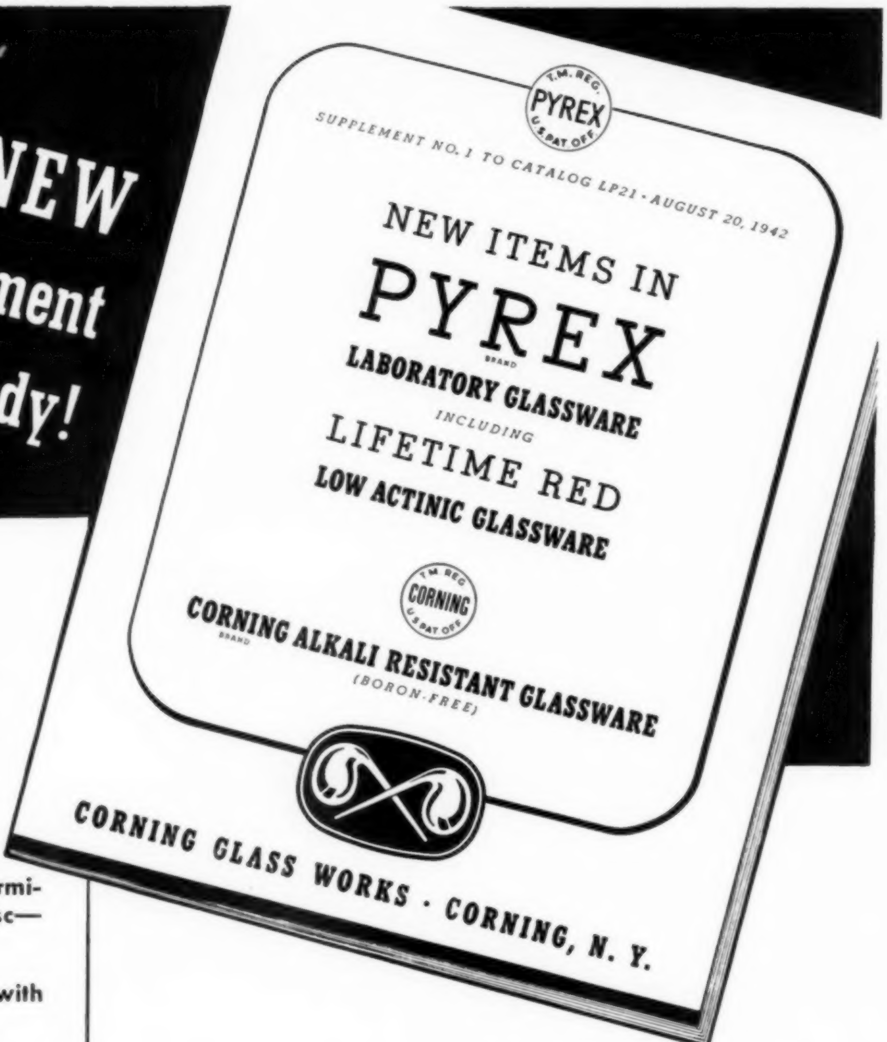

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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

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We *Counsel* You . . .

To begin the new school year with the determination to teach better this year than ever before.

WE COUNSEL YOU

To subject yourself to a thorough self-examination to determine your teaching faults, and to strive to correct them whatever they may be.

WE COUNSEL YOU

To take into consideration the fact that the lives of the pupils under your direction, regardless of their ages, may have already suffered or will later undergo serious dislocations because of the War.

WE COUNSEL YOU

To prepare yourself to teach better by well planned courses of study at a university or by extension, or by following a definite program of reading.

WE COUNSEL YOU

To join associations, the scientific and pedagogical societies to which science teachers should belong. There is a certain inspiration, if nothing more, that comes from belonging to a group that is trying to help teachers do a better job. (See page 94.)

WE COUNSEL YOU

To attend the meetings, local, state, regional, national, of the groups of which you are a member. Perhaps your enthusiasm is flagging. You will be stimulated by contact with the most important persons in your field. (See page 94.)

WE COUNSEL YOU

To subscribe to (and write for) technical and professional journals. You *must* keep up-to-date in your information and teaching methods if you are to be a successful teacher. Your ideas may be valuable to others. Why not express them?

WE COUNSEL YOU

To make sure that you do your utmost in every way to promote the War effort. Victory will come the sooner.

Some Incidents in the Story of Magnetism

• By Thomas D. Cope, Ph.D., *(University of Pennsylvania)*
DEPARTMENT OF PHYSICS, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA.

In this paper Professor Cope gives a pleasing account of four incidents in the early history of magnetism that have recently attracted his attention.

He examines the claim that the great Saint Augustine was the discoverer of an important fundamental principle in electrostatics and magnetism.

The other incidents have to do with scientific thought and experiment in early Pennsylvania.

This article is based on a paper read before the Pennsylvania Academy of Science at Edinboro, April 3, 1942, and before the Pennsylvania Conference of College Physics Teachers at Immaculata, Pa., on April 17, 1942.

The four incidents to be recounted in this paper came to the writer's attention during recent months. Each offered a challenge to further inquiry. Not every question that proposed itself has been answered. But progress has been made, and here is what has been learned.

☆ ☆ ☆

The First Incident occurred in distant lands and in ancient times. In mentioning it, Buckley's *Short History of Physics* states that

> Saint Augustine "was puzzled why the lodestone refused to move straws and yet snatched the iron, and seems to be the first to have realized that the amber and lodestone attractions are manifestations of different properties."

Good Saint Augustine made experiments with amber and with the lodestone and recorded what he saw fifteen hundred years ago. And today students by the tens of thousands watch experiments with electrified bodies and with magnets and then report that magnets attract iron and straws alike. And quite recently some writers, who now know better, assured the public that moving electrons are drawn to the north pole of a magnet and are repelled from the south pole. They had failed to grasp the principle that Saint Augustine had mastered long ago.

If the claim be well founded that Saint Augustine was the first to realize that the attractions of amber and of the lodestone are manifestations of different properties, then Saint Augustine is to be regarded as a great discoverer of a fundamental principle in electrostatics and magnetism.

What is the basis for the claim? Suggestions to friends that they find it in the writings of Saint Augustine brought no answer to the question. Then the principle of "Do it yourself" was applied and results began to appear. A lucky inspiration suggested that Park Benjamin's *Intellectual Rise in Electricity* be consulted. If you are not acquainted with that delightful book make its acquaintance without delay. We were on the right track for Benjamin devotes three pages to "Saint Augustine on the Magnet" in the course of which he says:

> "The world waited for a dozen centuries before finally recognizing the distinction and separating the phenomena into those which were electric or amber-like and those which were lodestone-like or magnetic; but the first suggestion of it came, none the less, from the great philosopher and saint of the early church."

And the foot notes in Benjamin lead to chapter VI, book 21 of *The City of God* where one may read for himself Saint Augustine's own words about amber and the lodestone.

☆ ☆ ☆

The Second Incident brings us deep into modern times and to the young states of Virginia and Pennsylvania. One hundred and sixty years ago John Page of Williamsburg, Virginia, and David Rittenhouse of Philadelphia, were exchanging letters on scientific topics, among them the age-old questions of electric and magnetic phenomena, their similarities, their differences, and their interrelations.

In one of his letters to Page, Rittenhouse speculated about the structure of a magnet, saying:

> "I suppose then, that magnetical particles of matter are a necessary constituent part of that metal which we call iron, though they are probably but a small proportion of the whole mass. These magnetical particles I suppose have each a north and a south pole, and that they retain their polarity, however the metal may be fused or otherwise wrought. In a piece of iron, which shows no sign of magnetism these magnetical particles lie irregularly, with their poles pointing in all possible directions, they therefore mutually destroy each other's effects. By giving magnetism to a piece of iron we do nothing more than arrange these particles, and when this is done it depends on the temper and situation of the iron whether that arrangement shall continue, that is, whether the piece of iron shall remain for a long time magnetical or not."

A colleague, while preparing an article[1], asked "Where does the speculation of Rittenhouse fit into the long line of speculations about magnetism that men have made during the centuries?"

A sincere question calls for an honest answer, and it in turn calls for work. As the years have passed, what ideas have competent scholars entertained about the nature of magnetism and the structure of a magnet? Volumes have been written to answer this question. They can be found in libraries of scientific literature.

Continued on Page Ninety-five

A Science Society for Honor Students

● By Sister M. Rosaire, I.H.M.
ST. MARY OF THE MOUNT HIGH SCHOOL, PITTSBURGH, PA.

Teachers of other dioceses may well consider adopting the plan which the Pittsburgh Diocese is now using to encourage and aid students, who show a special aptitude for science, to continue their studies in the fields in which they seem most likely to succeed.

The Science Society described by Sister M. Rosaire, who has been instrumental in organizing and guiding it, is not yet a year old, but it already has to its credit a number of important accomplishments. As it grows in strength and prestige it will be able to make significant contributions to science and education in the Pittsburgh district.

●

Every war exposes physical, mental and moral weaknesses; this war is no exception.

When the majority of men and women of the world strain their abilities to the point of endurance, they become aware that their visionary accomplishments far exceed their real. American scientists too, are failure conscious; hence, the challenge thrown at the educators: "Rigorous, 'hard' education must return,—easy schooling can no longer serve America's needs." Professional educators in America are challenged to produce "highly expert, fully qualified, technical and scientific specialists."

The Consumer's Research Bulletin of February, 1942, declares that, "The percentage of high school pupils studying physics is now only about a third what it was in 1910, and the number is still decreasing, in an epoch when a solider grasp of the physical sciences is a veritable necessity, if not an underlying condition for national survival." The importance of the physicist may be better appreciated from the opinion of the British that "100 physicists might be as important to the safety of the nation as a million men in the army."

The science teachers of the Catholic schools of the Pittsburgh Diocese have not been slow to recognize the present needs of their nation. If cooperative action in the teaching field can promote national efficiency and national unity, these Catholic teachers are willing to use their professional skill and initiative to lay a foundation for the training of competent, scientific specialists in invention, design, production and distribution.

The first step toward this goal was the formation of a Diocesan Science Society for Honor Students by the Science Committee composed of the science teachers of the Diocese of Pittsburgh, appointed by Rev. Thomas J. Quigley, School Superintendent. This society was adopted by the Federation of the Catholic High School Students, under the direction of Rev. Cyril J. Vogel, for the purpose of increasing its educational possibilities and to give greater advantages to its members.

The Federation itself has a membership of ten thousand students from forty-six Catholic high schools in Western Pennsylvania. Half of these schools now have members registered in the Science Society. The membership of the organization is limited to one hundred and fifty students. Each school is apportioned members according to its registration. Scholastic accomplishments determine eligibility for membership, a factor rated by the local science teachers.

The society began to function in February, 1942, with a series of demonstration-lectures, given by well-known specialists. Scheduled lectures included: Highlights of Sound, Dr. Fitz Hugh Marshall; Polarization of Light, Dr. W. N. St. Peter; Spectroscopy in the Modern World, Dr. Mary E. Warga; Chemistry in the Commercial World, Dr. William P. Schiller and Sister M. Lawrence, R.S.M.; Blood and Blood Forming Organisms, Sister Francis Xavier, R.S.M., and Dr. James Finn. The first of this series was conducted at the Buhl Planetarium and Institute of Popular Science, the second and third in the University of Pittsburgh laboratories, and the fourth and fifth at Mount Mercy College. The lectures were presented on a college freshman level. The apparatus used was superior to the types available in most high school laboratories.

The second project sponsored by the Society was a series of three broadcasts which were delivered over Radio Station WCAE during school hours by members of the Federation. Subjects of a scientific nature were developed with the hope that listeners would become better acquainted with historical scientific facts, and develop a keener sense of gratitude toward men who have unselfishly devoted their lives to the betterment of society.

Representatives from the Science Society were invited to participate in a Science Quiz Program over Radio Station KDKA, under the sponsorship of the Buhl Planetarium and Institute of Popular Science. A scholarship to Carnegie Institute of Technology was awarded to one of the Society's members for his display of scientific knowledge during the broadcast.

Having selected the members of this newly organized society because of their scholastic accomplishments in science, the Science Committee is now endeavoring to further their education in the fields in which these students seem likely to succeed. Appeals for scholarships have been made to local universities and colleges. These scholarships are sought as awards to the winners of competitive examinations, held under

Continued on Page Ninety-four

Transcriptions in Radio Education

• By Thomas D. Rishworth
DIRECTOR OF PUBLIC SERVICE PROGRAMS, NATIONAL BROADCASTING COMPANY, RADIO CITY, NEW YORK, N. Y.

Whether you realize it or not, teaching by radio transcription is here. More than 3,000 high schools are now equipped to play low-speed, 16" recordings. Transcriptions in a number of fields are already obtainable. Others will soon be ready, bearing the approval of classroom teachers and other educators as well.

If this teaching device is not familiar to you, you should learn its advantages and limitations. If your school does not now have suitable playback equipment, the War will delay its purchase, but eventually you will probably have to have it. Mr. Rishworth gives a number of useful teaching hints for those who are able now to use recordings.

This paper was read by the author at a recent meeting at Northwestern University.

Radio education has passed in the last fifteen years through a great many phases of development. There was a time when the average educator looked upon radio as a toy for young lads interested in Morse code. Then came the time when radio began to assert itself as more than a mere means of communication. It became a new force on the social horizon, and educators themselves turned their attention to this new medium, and found it—little less than adolescent.

Universities and colleges began to experiment. The radio engineering department of the university no longer looked on radio as a laboratory experiment. They recognized it as a means of promoting the larger purposes of the institution, perhaps destined some day to become a nation-wide classroom of the air.

And broadcasters were also awakening to the possibilities of radio. They discovered that the program was a means of developing community consciousness. They went further. They recognized that radio, and the license to operate a station, implied a responsibility for service to the public. Here and there radio stations began to explore the possibilities of radio in the school, in the college, in the church, the home.

Yet, the broadcaster and the educator frowned at each other; yes, even did a bit of growling. The broadcaster,—so said the educator—was a pernicious influence. The educator,—so said the broadcaster — was something akin to the camel, who can go two weeks, or is it three, without water.

But there were prophets who said that the two factions could cooperate. The radio program planner was a showman. He knew the techniques for attracting an audience and holding it. The educator was a teacher. He knew the techniques for awakening curiosity, for developing mental balance, for judging experience, for exploring the mind. Each had something to offer the other.

The combination was obvious, and what's more, it was effective. The broadcaster welcomed the educator, and the result was a nationwide effort to develop broadcasts for classroom reception. The Nation's School of the Air appeared on the horizon. State departments of education adopted radio as an essential part of the curriculum. Radio stations appointed trained educators who were also experienced in radio showmanship as full-time educational directors.

Then, with the great development of network broadcasting came the realization that classroom broadcasting, desirable as it was, could not reach the classrooms of an entire nation simultaneously because of the simple geographical barrier of time zones. A given broadcast might reach the schools of the eastern time zone at an acceptable hour, but the same program might actually reach the schools of the west coast early in the morning before the schools had opened. A series of programs in the social science field might be presented at an hour appropriate for the schools of Portland, Oregon, but at an hour that was directly unsuited for the schools of Dallas, Texas.

The National Broadcasting Company has given earnest thought to these problems for many years. As experience accumulated, we have become convinced that the one solution to the problems involved in the reception of educational broadcasts was to be found in the recording or transcription. A policy was developed, under the guidance of Dr. James Rowland Angell, public service counsellor of the National Broadcasting Company, and President-Emeritus of Yale University, which confined the classroom efforts of this network to a single series of programs, perhaps the oldest and most universally accepted of them all, the Music Appreciation Hour, under the direction of Walter Damrosch. In all its other educational efforts, the National Broadcasting Company determined to devote its activities in the educational field to presenting programs at an hour designed to secure the largest audience, regardless of the classroom possibilities of a given series, and to explore the advantages of the recording.

Through the recording, a broadcast, transcribed from actual broadcast, could be made available to the schools and colleges of the nation to be heard by the students at an hour most acceptable to the teacher and the class.

Meanwhile, the educational institutions of the nation had become interested in the recording as a teaching

aid. Many educators had discovered that broadcasts of the greatest historic significance were presented, material that could well be preserved as a permanent addition to a "sound" library for future reference by classes in history, civics, economics, drama.

As the result of further experimentation, teachers were discovering that records presented advantages in permitting repeated playings or playing in part only. Sections of a program that might not be readily intelligible on first hearing could be repeated merely by replacing the tone arm on a reproducer.

Further, a single record might be adapted to several classes and rotated at need from one room to another in the school. Compared to the phonograph record, on a ten or twelve inch disc, playing only three and one-half to five minutes, the sixteen inch transcription enabled the teacher to give her class in one uninterrupted playing an entire fifteen minute program. This avoided the psychological obstacle of interrupting the continuity of the program to reverse the record.

Studies were instituted at several institutions, the most important of which were the projects at Ohio State University and the American Association of School Film Libraries. Recordings were tested under scientifically controlled conditions, results were compared, and the effects were uniformly satisfactory, provided all factors required for adequate reception conditions and proper utilization practices were observed.

It must be admitted that much of the pioneering that led to these experiments occurred in the visual education field. The success of films as teaching aids had already been proved, and schools and colleges everywhere had already begun to establish film libraries. Record libraries were merely an extension of this idea.

Our experience at NBC has indicated an immediate need for an educational recording service to the schools. Requests for recordings of educational programs or for information concerning the use of recordings are evidence of a growing demand for an extension of the educational facilities of the radio networks. These inquiries come not only from the classroom but from museums and adult groups, from welfare agencies and civic organizations.

There are now approximately twenty-three manufacturers or educational organizations engaged in the production of recordings for educational purposes. These include not only the commercial manufacturers but the Harvard Film Service, the Federal Radio Education Committee of the U. S. Office of Education, the U. S. War Department, the National Council of Teachers of English, the American Council on Education, the American Automobile Association, the National Tuberculosis Association, the American Youth Commission, the Boy Scouts of America, the Girl Scouts of America, and others. However, none of the present services now in existence are equipped to provide recordings in all of the fields represented by NBC public service programs, and none have the program source material available to a network operating on a national basis seven days a week with broadcasts originating in all parts of the world.

Recordings now available on the market fall largely into these categories: language, history, music, literature, safety, speech, American folklore, and children's stories. It is obvious that this comprises merely a sampling of the fields that might be covered by a comprehensive and well-correlated recordings service.

In a recent survey conducted by the United States Office of Education, every high school in a city of thirty thousand or more in population was questioned. The results indicate that more than three thousand high schools in this country are now equipped to play low speed, sixteen inch records. On this basis, in the classroom of the high schools alone, we have a potential audience of more than two million students. To this total can be added hundreds of independent adult groups to which playback machines are available for occasional use: discussion groups, women's clubs, parent-teacher associations, Americanism classes, YMCA's, youth agencies, and others.

In terms of actual sales, the Federal Radio Education Committee reports a gross revenue of $6,000 as of July 1, 1941. This represents a total sale in two years of 2,700 — 2,800 records. The Association of School Film Libraries reports sales of 1,215 recordings of the "Cavalcade of America" series, presented weekly on the NBC network by the Dupont Company. One company reports sales to 850 schools in the English literature and American history fields. Another reports sales to more than eight thousand schools in the literature, speech, Americanism, and foreign language fields.

A further indication of the extent to which recordings are being used comes from the Federal Radio Education Committee which has a total of 16,000 individual transcriptions available on a loan basis. These transcriptions represent 72 different programs, and requests for information have come from 1,394 schools or individual teachers. Later statistics would certainly increase this figure by fifty per cent at the very least.

In Los Angeles, the Visual Education section of the city school system has a library of 758 transcriptions, comprising 103 different programs, available on loan. The Association of School Film Libraries lists in its catalog more than 600 individual programs for school use, a few available on loan but the great majority for sale only. In Rochester, New York, Paul A. Reed, Director of Visual and Radio Education, reports that a total of 380 programs were used in the classrooms of that city. Mr. Reed has recommended to every school in the city the purchase of a two speed portable transcription playback. This would include the elementary as well as high schools. In San Francisco, another central lending library of recordings has been established, and plans are now under way to extend this service to six additional counties in the greater San Francisco area.

Continued on Page Eighty-six

Federal Regulations Which Control or Affect the Purchase of Science Supplies

● By E. S. Russell
CAMBOSCO SCIENTIFIC COMPANY, BOSTON, MASS.

Teachers who are responsible for the purchase of laboratory apparatus and materials are sometimes confused by the numerous restrictions that have been placed on sales by various Federal agencies.

Realizing this, the Editor asked Mr. Russell to abbreviate and simplify some of the more important regulations, so that users may understand why certain chemicals and apparatus may no longer be freely obtained. This brief and to-the-point article is the result. You will appreciate it the more when we tell you that one of the official documents is fifty pages long.

Readers should not fail to note the concluding paragraph carefully. In it Mr. Russell stresses the fact that all regulations of the War Production Board are subject to change at any moment without warning to anyone.

He also states that quotations from official documents are enclosed within quotation marks. The opinions expressed are his own and are not to be construed as official.

●

More and more for Mars means less and less for the laboratory; but Americans who put first things first would countenance no other course. First choice of existing equipment, and first call on stock piles of raw materials, are cheerfully conceded to producers of guns and ships and tanks and planes.

What about second choice? In a totalitarian state, the answer would be: "None." Makers of the munitions of war would receive one hundred per cent of the available supply. The American way, on the contrary, contemplates allocation of scarce materials on the basis of demonstrable need, with a minimum of disruption for any enterprise as essential as education.

To that end, hundreds of federal regulations have been promulgated to govern the production, purchase and sale of many thousands of commodities. Several of those regulations are of direct concern to teachers of science, for whose convenience their terms and requirements are abstracted in the paragraphs which follow.

Preference Rating Order P-100 Provides A-10 Rating for Operating Supplies

By the War Production Board, all educational institutions have been granted the privilege of using Preference Rating A-10 on orders for essential operating supplies. The authority is provided by Preference Rating Order No. P-100 (as amended February 10, 1942). From that order, the following pertinent definitions are taken:

> "Operating Supplies" means any Material which is essential to the operation of the producer's business, and which is consumed in the course of such business.
>
> "Material" means any commodity, equipment, accessories, parts, assemblies, or products of any kind.
>
> "Producer" means (among other forms of enterprise) educational institutions.

In case of doubt, the precise interpretation of these definitions should be sought in the context of the Preference Rating Order. There, certain exceptions and restrictions (which seldom apply to school purchases of science supplies) are clearly set forth.

A most important provision is that the purchaser, in order to apply the preference rating ". . . must endorse the following statement on the original and all copies of the purchase order or contract for such material manually signed by a responsible official duly designated for such purpose . . ."

The correct endorsement, which may be written, typed, rubber-stamped or printed on all copies of the purchase order, is as follows:

> "Material for Maintenance, Repair, or Operating Supplies—Rating A-10 under Preference Rating Order P-100 with the terms of which I am familiar."

Name of Producer ____________

Signature of Designated Official ____________

Educational buyers should note that "Name of Producer," in the stipulated endorsement, is to be followed by the name of the educational institution, and that the endorsement must be technically correct in every detail.

Use of the A-10 Rating, with proper endorsement, enables the dealer to "extend the rating," i.e., to replace materials taken from stock to fill a rated order.

Limitation Order L-144 Requires Certification of Laboratory Equipment Orders

On June 12, 1942, the War Production Board issued General Limitation Order No. L-144, which defines Laboratory Equipment as: "Material, instruments, appliances, devices, parts thereof, tools and operating supplies for laboratories, or for use in connection with operations usually carried on in laboratories, not including second hand items."

The order, which of course has the force of law, provides that:

"No person shall sell, deliver, rent, purchase, acquire or accept delivery of Laboratory Equipment in which there is incorporated or used—

Aluminum
Chromium
Copper
Iron
Magnesium
Molybdenum
Nickel
Steel
Tantalum
Tin
Titanium
Any alloy of said metals
Rubber
Neoprene (or other synthetic rubber)
Non-cellulose base synthetic plastics

except pursuant to a purchase order or contract having certified thereon a statement in the following form, signed manually, or as provided in Priorities Regulation No. 7, by an official duly authorized for such purpose:

"CERTIFICATION: The Laboratory Equipment herein ordered will be used or sold in conformity with the provisions of General Limitation Order No. L-144 with the terms of which the undersigned is familiar.

Name ______________________________

By ______________________________

(Signature of Duly Authorized Official)".

Use of that certification, on orders from educational institutions, is covered by Section (b) (2) (v), which authorizes purchase of Laboratory Equipment—"to the extent necessary for repair parts and operating supplies for the maintenance of existing essential equipment and activities in laboratories."

It should be noted that certification, in accordance with the terms of Order No. L-144, does not take the place of a Preference Rating; that orders for apparatus involving rubber, plastics, restricted metals and their alloys will require both rating and certification.

Priorities Regulation No. 10 Assigns Allocation Classification Symbols

To facilitate identification, alike of materials and of their ultimate purchasers, the War Production Board requires the use of alphabetical and numerical symbols "by every person placing a purchase order or contract."

Domestic Purchasers are designated by the letter-symbol DP.

Materials and supplies for educational work are identified by the number-symbol 17.20. To quote from the Regulation: "Schools, colleges, universities, and other educational institutions should place this allocation symbol on all purchase orders that they issue."

It is further provided that: "The appropriate purchaser's symbol should in each case precede the numerical allocation symbol." In other words, educational orders must be marked: DP 17.20.

Federal Explosives Act Requires Analyst's License for Explosives Ingredients

A Federal License is now required for the purchase, possession, or sale of more than one ounce of the following chemicals:

Acid, Perchloric, and its salts
Acid, Picric, and all picrates
Ammonium Nitrate
Barium Chlorate
Barium Nitrate
Phosphorus, white or yellow
Potassium Chlorate
Potassium Nitrate
Sodium Chlorate
Sodium Nitrate
Strontium Chlorate
Strontium Nitrate

all of which, for the duration of the war, have been defined as "explosives ingredients."

For educational work, an Analyst's License—good for one year—may be procured through a local licensing agent, or directly from the U. S. Bureau of Mines at Washington, D. C. In either event, one certified copy of the original license should also be obtained.

The Federal Explosives Act expressly states that: "No sale shall be made . . . unless a certified or photostatic copy of the purchaser's license is on file in the seller's office."

School Superintendents, and others who buy for more than one educational institution will be interested in the following ruling, made on April 15, 1942, by the U. S. Bureau of Mines:

"If purchases are made by a school system or school department, which supplies other schools in the city, a single license may properly be issued to such department or system. If the schools purchase separately, and are billed separately, each school will require its own license."

Revenue Act of 1941 Imposes Excise Taxes on Optical Instruments

Under the Revenue Act of 1941, an excise tax is imposed upon many optical instruments, including:

Cameras
Colorimeters
Micro-Projection Apparatus
Microscopes
Optical Measuring Instruments
Photographic Apparatus
Photo-Micro Apparatus
Projection Lenses and Prisms
Polariscopes
Refractometers
Spectrometers
Spectroscopes
and kindred equipment.

It is provided, however, that certain institutions . . . including public schools . . . may make tax-free purchase of optical equipment for their exclusive use. The Revenue Act provides that—

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Chromosomes

And Their Behavior in Cell Division

• By Reverend Charles A. Berger, S.J., Ph.D., *(Johns Hopkins University)*
BIOLOGICAL LABORATORY, FORDHAM UNIVERSITY, NEW YORK, NEW YORK.

In this paper Father Berger first gives a brief history of chromosomes, essential components of cells which play an important role in the specificity of organisms and in their development and heredity.

The morphology of chromosomes is then discussed. A study of their spiral structures follows. The most acceptable current opinions on spiralization are considered. Attention is given to the time and manner of chromosome division and to the relation of chromosomes to the spindle.

This article deserves study, not mere reading. It gives teachers something to "put their teeth into." Some of the information given here is not readily accessible to many teachers of science.

The cell, the unit of living matter, is a highly complex organized system. Of the many essential components of this system the most significant are the chromosomes. These bodies are most evident during the division of the cell when they take biological stains more deeply than other cell structures. The role played by chromosomes in the specificity of organisms and in their development and heredity is of such crucial importance that they may with probability be considered as the most important material bodies in the universe. In the chromosomes matter may be said to reach its highest and most significant level of organization.

We do not know who discovered chromosomes. They were certainly known as early as 1848 when they were seen and accurately drawn by Hofmeister. The name chromosomes was first used by Waldeyer in 1888. Their significance began to be realized about 1870 through the work of a group of brilliant investigators. Flemming, Strasburger and Van Beneden worked out the main outlines of mitotic cell division including the longitudinal division of the chromosomes. About the same time Hertwig, Boveri, Montgomery and others soon showed that the number of chromosomes is specific for a given organism and consists of two sets, one of maternal and one of paternal derivation. Ripe germ cells were shown to contain only one set of chromosomes and the members of the set to differ in size, shape and constitution. These differences were found to be constant, and normal development was shown to be dependent on the presence in the fertilized egg of two complete sets of chromosomes. Although they are usually not visible in the resting nucleus, chromosomes retain their individuality from cell generation to cell generation.

These fundamental concepts were known at the time of the rediscovery of Mendel's work. With the rise of the science of Genetics it soon became abundantly demonstrated that the chromosomes are the material basis of hereditary differences.

Thus knowledge of the functional importance of chromosomes was considerably in advance of our understanding of their structure. Progress in this direction has been slow due to the smallness of the structures investigated and the technical difficulties involved. The purpose of this paper is to present the more probable opinions on chromosome structure as shown by recent research.

Morphology of Chromosomes

In different organisms the length of chromosomes at metaphase ranges from .2 of a micron to 32 microns. Each chromosome has along its length a region known as the primary constriction or spindle attachment region. This structure appears as a constriction in a metaphase chromosome but is actually a slight swelling on the long thin prophase chromosome. During anaphase separation this region precedes the rest of the chromosome towards the poles of the spindle, thus giving it one of four characteristic shapes. A terminal primary constriction results in a rod shaped chromosome, a median constriction gives a V shape and a subterminal constriction gives a J shape with unequal arms. Very short chromosomes appear as small spheres. Some geneticists and a few cytologists are of the opinion that there are no strictly terminal primary constrictions and that those apparently terminal are really slightly sub-terminal. This view is not generally accepted. The primary constriction is also known as the kinetochore, and in genetical literature as the centromere. Some geneticists consider the centromere as a gene, but this view is not commonly held and is probably incorrect.

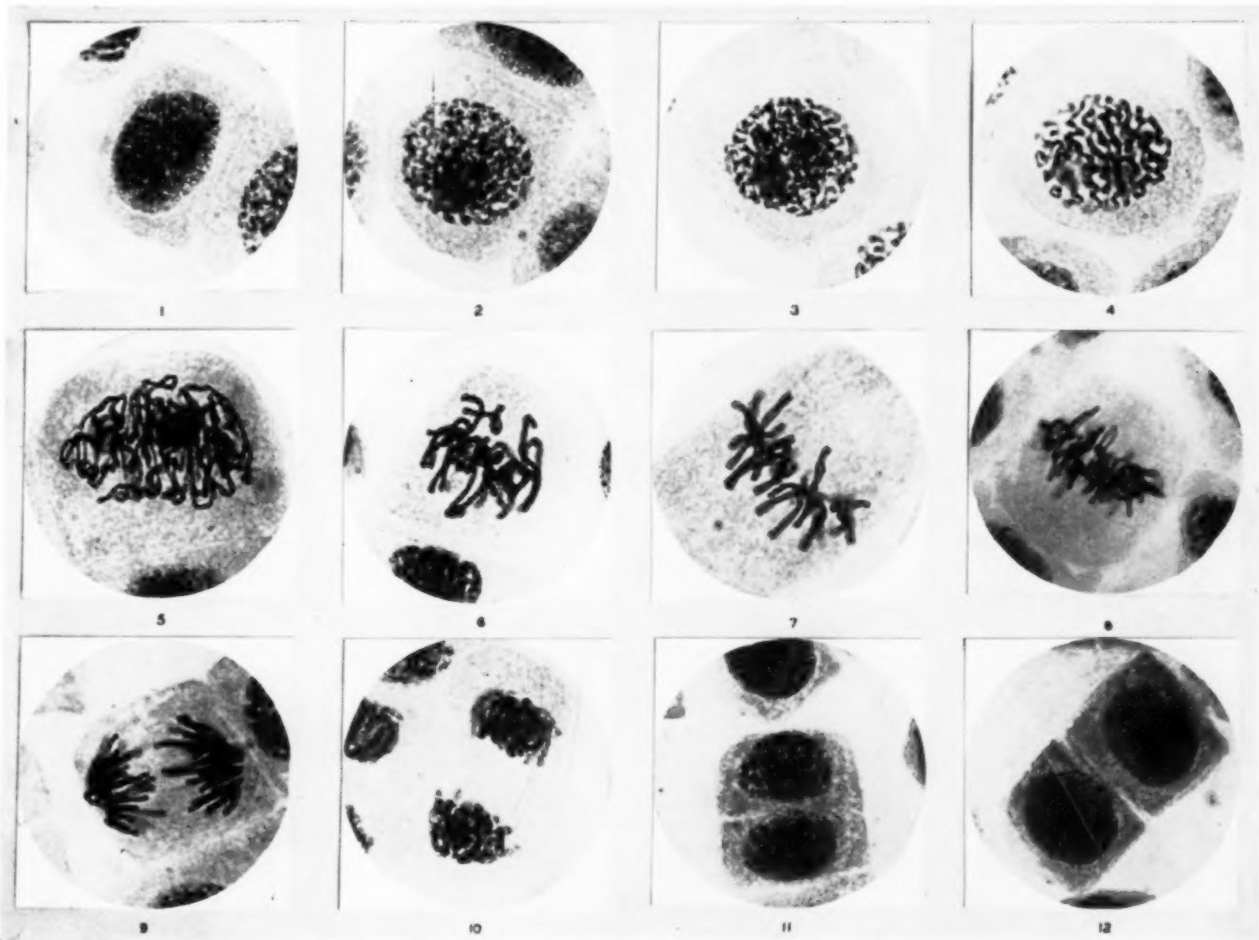
Some recent evidence indicates that there is a relationship between the centromere and the centrosome. Both of these structures are concerned with chromosome movements. The fine structure of the primary constriction has been studied in greatest detail by Schrader who sees the kinetochore as a compound body composed of two commissural cups with a central deeply staining spindle spherule. Recently a diffuse spindle attachment region extending the full length of the chromosome has been described by Hughes-Schrader. McClintock has shown that the spindle attachment region can be broken and each part remain functional. Apparently kinetochores reproduce only by division and are incapable of being formed *de novo.*

Chromosomes which have lost this region by fragmentation are incapable of directed movements and are left behind during mitosis and lost.

Another important differentiation along the length of many chromosomes is known as the secondary constriction. In most chromosome complexes at least one chromosome has one or more of these constrictions. They are of two types depending on their position. If situated near an end of a chromosome they set off a small end piece called a satellite or "trabant." Satellites were discovered by Navaschin in 1912 and have since been found to be very common in plants. The second type of secondary constriction occurs anywhere along the length of the chromosome except at its ends. Chromosomes with secondary constrictions have been termed SAT-chromosomes by Heitz who in 1931 showed that the nucleolus is regularly formed at the secondary constriction. This association of the nucleolus with the secondary constriction has recently been demonstrated experimentally by McClintock (unpublished). The varying number of nucleoli found in different cells is explained as follows. If there is only one pair of chromosomes with secondary constrictions the maximum number of nucleoli is two; if they happen to come into contact they will fuse to form one. If there are two pairs of SAT-chromosomes there will be a maximum of four nucleoli, or three, two or one as a result of fusion among the four original nucleoli. Heitz has also shown a correlation between the size of the nucleolus and the length of the secondary constriction.

Spiral Structure of Chromosomes

Chromosomes appear at early prophase as long thin threads or chromonemata. In favorable cases it can be seen that each prophase chromosome is double from its first appearance. From prophase to metaphase the chromosome decreases in length and increases in diameter. This contraction is due to a spiralization. A somatic metaphase chromosome is a double structure consisting of two chromatids, each coiled in a close spiral. As soon as these chromatids separate from each other at anaphase, they cease to be chromatids and become chromosomes.



MITOSIS IN ALLIUM.
1. 'Resting' Stage. 2-6 Prophase Stages. 7. Metaphase. 8-9 Anaphase Stages. 10-11. Telophase Stages. 12. 'Resting' Stage.

The problem of chromosome coiling and of the number of strands in chromosomes at different stages is very involved and obscure. The structures studied are at the limit of visibility with the best optical equipment. The difficulty is increased by a confusion of terminology. However it is possible by learning the meaning of a few carefully chosen terms to comprehend the essentials of the most probable current opinions on the coiled structure of chromosomes.

Two parallel strands may be coiled in one of two ways. In the first way the coils are independent and the coiled strands may be readily separated from each other. The relationship of such coils is said to be *paranemic*. If the two strands are coiled in such a way that it is impossible to separate them without previous uncoiling, the relationship is termed *plectonemic*.

The metaphase chromosome of mitosis is arranged in what is best termed a *somatic coil*. The two chromatids of this chromosome are coiled in paranemic relationship; they separate readily at anaphase without uncoiling.

At first meiotic metaphase the situation is more complex. Each chromosome now has a *major coil*, a large gyred spiral along the long axis of the chromosome, and a *minor coil*, a small gyred spiral along the coils of the major spiral and hence at right angles to the long axis of the chromosome.

Two other types of coils are best seen in prophase. A *relic coil* is a loose large gyred spiral resulting from the incomplete uncoiling of the previous anaphase coil. *Relational coiling* is the slight twisting about one another that occurs between two parallel strands. It is not a regular spiral.

The direction of coiling is not regular and reversals of direction are known to occur in both mitotic and meiotic chromosomes. These reversals may occur at the spindle attachment region or at any other place along the chromosomes. In this connection it is interesting to note that vine tendrils at times show a similar reversal in the direction of their coils.

Regarding the number of strands in a chromosome, the following opinions are widely accepted and highly probable. Somatic chromosomes at metaphase are clearly double being composed of two chromatids in paranemic coils. It is probable that each of these chromatids is composed of two half chromatids in plectonemic coils. In some cases of large chromosomes there is good evidence that somatic anaphase chromosomes are composed of two chromatids which are probably in a plectonemic coil.

At first meiotic metaphase chromosomes are synapsed in pairs (bivalent chromosomes or tetrads). Each tetrad consists of four chromatids. In *Trillium* where the first and the second meiotic divisions are not separated by an interphase (short resting stage) the chromatids are in paranemic coils and hence the four chromatids of the tetrad are able to separate in the two divisions without uncoiling. In *Tradescantia* there is an interphase between the first and the second divisions and some observers report that the chromatids of the tetrad are in plectonemic coils; however, this is disputed by other observers.

In some favorable cases of very large chromosomes, for example, *Trillium*, it has been shown that each chromatid of the tetrad is also double, being composed of two half-chromatids. Where half-chromatids are visible with any degree of clarity they appear to be in a plectonemic relationship.

The time and manner of chromosome division is also a subject of controversy. The division of a chromosome is in all probability a twofold process involving first a reproduction of the chromonemata, and secondly the separation of the reproduced elements. The separation of the two elements obviously takes place at anaphase. The actual reproduction of the chromonemata has been placed at all four stages of mitosis and in the resting stage by different observers. The most probable opinion is that this reproduction takes place during the resting stage. The most convincing evidence for this view comes from some work on the mosquito, *Culex pipiens*, (Berger, 1937). At the beginning of larval life the hind-gut of the mosquito larva is composed of small diploid cells with six chromosomes. For the two weeks of larval life these cells remain in the resting stage but increase greatly in size. At the beginning of pupal metamorphosis these enlarged cells begin to undergo mitosis and at the first prophase it is seen that there are forty-eight or ninety-six chromosomes in each cell instead of six. In this case the chromosomes have undergone three or four successive reproductions during the long resting stage of two weeks. Less direct evidence of other recent investigators confirms this opinion that chromosomes reproduce themselves during the resting stage.

Relation of the Chromosomes to the Spindle

The mitotic spindle of most animal cells is composed of the following structures. At each pole there is a centriole from which radiate a number of *astral rays*. In most, but not all, animal cells *continuous spindle fibers* extend from pole to pole and form the *central spindle*. At metaphase the spindle attachment regions of each chromosome lie on the equatorial plate of the spindle, the arms of longer chromosomes trailing out into the cytoplasm. *Half-spindle fibers* (also called chromosomal fibers and tractile fibers) start out from the spindle attachment region of the chromosome and extend to the pole. The nature of these fibers is not known with certainty but there is good evidence that they are not solid fibers which contract and pull the chromosomes to the poles, nor are they merely artefacts. They are differentiations of the spindle substance concerned in some way with chromosome movements.

In animal cells when the chromosomes separate at anaphase another set of fibres appears connecting the

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Photoelectric Phenomena

• By Walter L. Long
CENTRAL SCIENTIFIC COMPANY, CHICAGO, ILLINOIS.

Students who have seen "electric eyes" open and close doors or regulate the illumination of their classrooms, and who know that certain kinds of burglar alarms, counting devices and sorting machines, as well as talking motion pictures, require their use, will be keen to learn what photoelectric cells are and how they operate. The teacher must not disappoint them.

The apparatus required for demonstration is comparatively simple and inexpensive. It makes an interesting demonstration. Members of the Chicago Catholic Science Teachers Association know this to be true, for recently Mr. Long demonstrated before one of their meetings the apparatus he here describes.

Are YOU keeping your science teaching up-to-date?

●

Photoelectric cells are being used more and more in the solution of practical problems in the laboratory, in the home and in industry. Their use is of such importance that nearly everyone is interested in them. This is particularly true in the field of secondary education where teachers and students alike are interested in the way these cells function. It is the purpose of this paper to describe briefly an inexpensive unit which makes it possible to demonstrate the principles of the photoelectric cell and to show a number of its possibilities and practical applications. With such a device one can learn a great deal about photoelectric cells without an extensive knowledge of electronics.

The apparatus consists of a photocell-relay control unit and a light source. The light source, which is supplied with an infra-red filter, may be located at some distance from the photocell-relay control unit. The two units may be directly connected to the 110-volt A.C. power line. The light source furnishes the infra-red light by means of which the photocell, through the relay unit, controls various circuits. This apparatus is illustrated in Fig. 2. A wiring diagram of the photocell-relay control unit is shown in Fig. 1.

The photoelectric cell employed is of the emissive type and has sufficient sensitivity so that it may be operated by the light placed some twenty feet from the control unit. It consists of an electrode called the cathode, which is formed from a square sheet of copper into a semi-cylindrical surface and which is plated with silver and caesium oxide. The anode, or positive electrode, is a single vertical wire located at the center of curvature of the cathode. The two electrodes are insulated from each other and are mounted in an evacuated glass envelope. The glass envelope is sealed to a bakelite base, and the leads from the cathode and anode are connected to prongs on this base.

A large short-focus lens mounted on the control panel focuses the light from the infra-red source on the cathode of the photoelectric cell.

The photoelectric cell is connected in the grid circuit of the amplifying tube, and the relay is in the plate circuit of the same tube. A potentiometer, condenser, transformer and various resistances are provided so that the unit will function properly. The contacts of the relay are connected

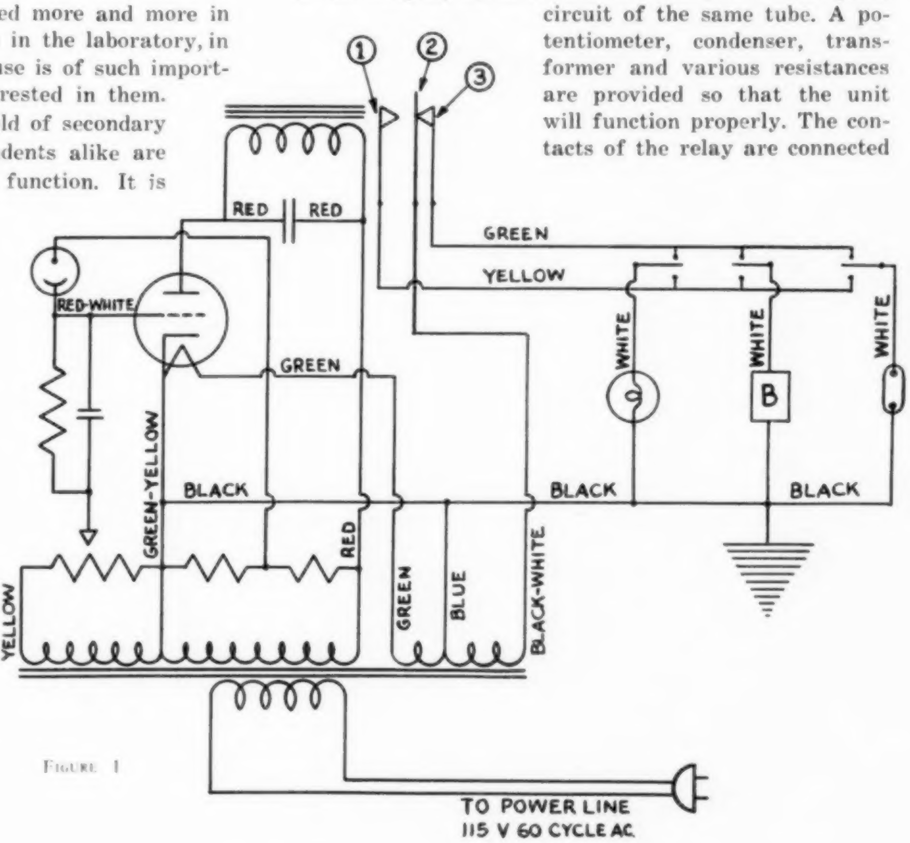

FIGURE 1

CIRCUIT DIAGRAM OF NO. 80936
CENCO PHOTOELECTRIC DEMONSTRATION APPARATUS

through an insulated low-voltage winding of the transformer. The relay is of the single-pole double-throw type so that the circuit containing an electrical device and the insulated low-voltage winding of the transformer may be either opened or closed by the action of the light falling upon the photocell. The transformer and contacts of the relay are capable of handling only a small amount of power, but they safely operate a small 6-8 volt miniature lamp, a buzzer or a similar device in which the current drawn does not exceed more than 0.5 ampere.

The potentiometer is adjustable so that the sensitivity of the unit may be adequately controlled. Three switches located on the vertical panel are provided to independently control circuits arranged in parallel through the contacts of the relay. The switches have three positions—neutral, connection to the normally open contact of the relay, and connection to the normally closed contact of the relay. One of the switches is connected in series with a small 6-8 volt lamp mounted on the front of the control panel. Another switch is similarly connected to a buzzer mounted within the unit, and the third switch to a terminal strip mounted on the panel. External devices which operate on 6-8 volts and draw not more than 0.5 ampere may be connected to this strip.

To illustrate a burglar alarm, the light source, placed at a convenient distance from the photoelectric cell unit, is focused on the photoelectric cell. Two of the switches—that is, to the light and to the external contacts—are set in neutral position. The third switch—that is, the one in series with the buzzer circuit—is set to give an open circuit when light from the source is falling on the photo-cell. The potentiometer is adjusted to give proper grid voltage to control the power relay. By placing the hand in the path of the light, thus changing the potential on the grid of the amplifier through the action of the photoelectric cell, the relay is de-energized, closing the normally open contact, and causing the buzzer to sound. If the switch to the small light is also properly thrown, the light on the front of the panel will glow.

Assume that a bank safe is to be automatically protected by a similar type of apparatus. The light source is placed at one side of the safe in such a position that a horizontal light beam passes in front of the safe door. The photocell control unit is placed on the opposite side of the door. The small buzzer used in the demonstration apparatus is replaced by a larger, more audible electric bell placed on the outside of the building. Any interference in the path of the light falling on the photoelectric cell will cause the relay to function and set off the alarm. Such apparatus is generally designed with a type of relay which will cause a continual alarm until it is reset. Hence the continuous interference of the light falling on the photocell is unnecessary to satisfactory operation of the alarm. Usually infra-red light is used so that the light falling on the photocell is not visible to the intruder.

Recently another type of burglar alarm has been designed. The relay of this device is connected in the same manner as described above to give the alarm. A second relay is also installed which is connected so as to set off a photoflash bulb and to operate the shutter of a camera with a wide angle lens. Thus a photograph is actually made of the person who sets off the alarm.

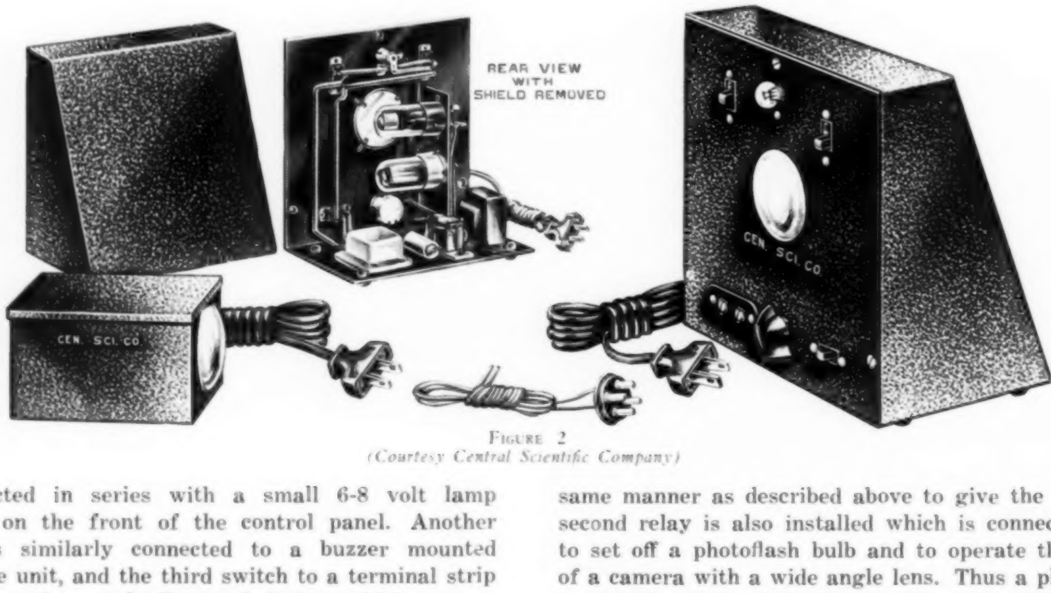

FIGURE 2
(Courtesy Central Scientific Company)

To illustrate another use of the photoelectric cell, the demonstration panel is replaced with a magnetic numerical counter. Sometimes the state highway departments wish to make a survey of the number of automobiles using a highway. The light is placed on one side of the road and the photocell control unit on the other side. Machines passing through the path of light automatically operate the counting device. The photoelectric cell may be employed as a safety device. The light source and power relay are properly adjusted so that when a human hand is in a dangerous position the power supply to the machine is automatically disconnected.

Some stores use the photoelectric cell to open and close doors. In this set-up, two photocells and relays are used, one on one side of the door and one on the

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Collecting Butterflies, A Scientific Challenge

● **By Ralph L. Chermock, M.S.,** *(Duquesne University)*
DEPARTMENT OF BIOLOGY, BEAVER COLLEGE, JENKINTOWN, PENNSYLVANIA.

The "butterfly catcher" with his net is frequently considered a simpleton by persons who do not understand what he is doing and who do not take the trouble to find out. Perhaps, at times, even you have been one of the pitying head-shakers.

Here a brilliant young lepidopterist defends his hobby convincingly. It may give you a new slant on butterfly collecting.

You will be interested in what he has to say concerning the possibilities for productive research in this field.

●

A few years ago, while I was collecting butterflies in a pasture in Kentucky, a solemn looking gentleman on a brown mare approached me and inquired what I was doing. After I had explained to him in considerable detail why I was in his field he said, "I can't see why you collect butterflies. They are so useless. Why can't you be a horse fancier, like me?"

At the time I did not wish to provoke the equestrian, but the temptation to justify the hobby of collecting Lepidoptera was very strong. This article is written to do it now. I shall try to illustrate, too, how biological principles can be crystallized in the minds of "butterfly catchers," eventually leading workers to research that may greatly broaden our knowledge of vital activity in general.

All fields of endeavor must have a beginning. As the first stage of becoming a butterfly student one may visualize a youngster creeping cautiously toward a large black and yellow swallowtail perched precariously on a magenta-tinged thistle. With the closing of those pudgy, clumsy hands the lad has captured his first butterfly. It is quite likely that in the process the scales have been rubbed off so that the butterfly is beyond recognition, and probably the wings have been broken.

Embryonic lepidopterists soon graduate to the net-and-cyanide-jar stage when hours are spent collecting the fragile insects, carefully mounting them on pins, and proudly placing them in insect boxes. If they are scientifically minded, these enthusiastic workers keep records of each insect, noting where and when the specimens were collected. They study the rudiments of taxonomy from such books as W. J. Holland's *Butterfly Book*, or Macy and Shepard's *Butterflies*.

Slowly their collections grow until they may have all or most of the butterflies of a certain county, state, or region. It is usually at this time the "bug-catcher" reaches a branch in the road. One fork leads to the "stamp collector" swamps, where the nascent entomologist becomes bogged down with the idea of adding more and more specimens with no purpose other than to build a large collection. The other road leads to the scientific beyond, a never ending road lined on either side with countless interesting and fascinating problems. It is the second branch which is worth while. It deserves consideration.

To select the road of science, one must approach the subject with a sense of curiosity. The questions How? and Why? created science and research. They have always been the guiding lights used by scientists in their quest for knowledge. When these words guide the entomologist during his collecting and his studies, a new world of endless problems presents itself. We shall discuss briefly some of the important trends of research in this field to show what has already been accomplished, and, perhaps, to offer suggestions concerning possible lines of research that might prove fruitful.

In the study of lepidoptera, as in all biological sciences, taxonomy is an important subject, a useful tool that forms the foundation for further work. Because the basis for speciation to a great extent depends on color pattern, which is extremely variable in butterflies, numerous questions arise as to what really constitutes a species. Subspecific nomenclature is used frequently. Experiments involving the physiological basis for pigmentation have demonstrated that these beautiful colors are usually excretory products deposited in the wings during the pupal stage. The color pattern can be influenced and changed by environmental factors such as temperature variations, percentages of moisture in the air, gases existing in industrial areas, and air pressure as a result of altitude. Any given species, throughout its range of distribution, encounters great differences in environment which can influence pigmentation, on which species determination depends. A great deal of work involving careful studies of distribution and environment in the evaluation of the nomenclatorial system remains to be done, and must be accomplished before any concept of the evolutionary origin of our lepidoptera can be determined. Very little in the way of palaentological records exist, and the history of this group of insects on our earth can be determined only by indirect, but logical methods. The answer lies in distribution and variation.

Anatomical studies are also important in taxonomy. Certain groups such as the Hesperids can be definitely

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Wetter Water

By Norma Hajek

PRE-MEDICAL STUDENT, CORNELL UNIVERSITY, ITHACA, NEW YORK.

The new wetting agents have been accepted with cheers by industry. This is a simple account of how they work. It is also an example of good essay writing by a high school science student.

In 1941 this paper won for Miss Hajek the gold medal given by the Western New York Section of the American Chemical Society, and for East High School, Buffalo, N. Y., for one year's possession, the gold cup offered by the faculty of the University of Buffalo.

The paper was read at the Junior Science Congress of Western New York at Buffalo, in May, 1941, and at the New York State Science Teachers Convention at Syracuse in December of the same year.

Unbelievable as it may seem, water can be made wetter.

This "wetter water," which is applicable in numerous phases of industry, is procured by employing a wetting agent. The function of such agents is to lower interfacial or surface tension, which does not permit the penetration of water through oily films or fibers.

This may be proved by filling a two hundred mesh screen with ordinary faucet water. The water does not run through the screen because the surface tension of the water is great enough to fill in the holes and hold up the water above it. However, when a small amount of a wetting agent (5-10 c.c. of a 2% solution of Novonacco*) is added, the water immediately runs through. This happens because the wetting agent has reduced the surface tension to such an extent that it is no longer strong enough to hold up the water.

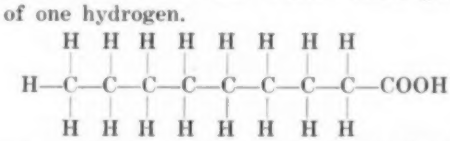
The molecule of such an agent consists of two parts. One portion is called *hydrophobic* or water insoluble; the other, *hydrophilic* or water soluble.

The hydrophobic portion consists of single or double bonded hydrocarbon chains which are alkyl or aryl, or alkyl-aryl in structure. An alkyl structure means that the carbons are arranged in a chain formation, while in aryl, the carbons are in the benzene ring pattern. Alkyl-aryl is a combination of the two in which a hydrogen is removed from each, and the alkyl chain is then connected directly to the aryl ring to satisfy the carbon bond.

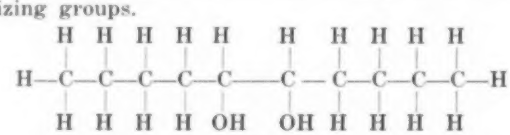
The best wetting agents, according to observations, have chains of ten to twelve carbons. Those in excess of twelve carbons, tend to react with water more as detergents (soaps) than wetting agents.

The hydrophilic or water soluble part of the molecule is composed of one of the numerous solubilizing groups, which include the carboxyl (-COOH), hydroxyl (-OH), sulfonate (SO_3H-), and sulfate ($=SO_4$) groups.

Some molecules consist of one long, single-bonded hydrocarbon chain and one water soluble portion in place of one hydrogen.



Others are formed by breaking the double-bonded carbon of a hydrocarbon chain and adding one of the solubilizing groups.



Stearic acid ($C_{17}H_{35}COOH$) exemplifies the long, single-bonded variety. The carboxyl group appears at the end of the long chain of seventeen carbons. For the double-bonded variety oleic acid ($C_{17}H_{33}COOH$) can be used. Its structure is similar to that of stearic acid except that it has a double-bonded carbon in the center of its long chain of carbons.

The reaction of the wetting agents with the surface depends upon polar groups. Water, being a polar group, tends to dissolve other polar substances. The hydrophilic groups are polar and therefore tend to dissolve in water. If the surface of the water has an oily film, the fatty part of the wetting agent molecule, which is the hydrophobic or water insoluble part, firmly adheres to the surface of the film. The hydrophilic or water soluble part extends, meanwhile, into the water and pulls the fatty film through the water.

This is readily seen when this experiment, using colored amyl alcohol, is performed. Two glass cylinders, colored amyl alcohol, and 25 c.c. of a 2% solution of Nacconal, NRSF† comprise the equipment. Both cylinders are filled with 50 c.c. of water and 10 c.c. of the amyl alcohol. There are two layers of liquid in the cylinders, amyl alcohol on top and water on the bottom. This occurs because the amyl alcohol is not miscible with water. When 25 c.c. of the wetting agent are added to the first cylinder and stirred, the alcohol becomes evenly distributed. Because the wetting action of the agent, as explained above, is permanent, the layers will not again form. The contents of the second

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*Novonacco is the product of the National Aniline and Chemical Company.

†Nacconal, NRSF, is produced by the National Aniline and Chemical Company.

Science Open House

● **By Sister Mary Silva, O.S.F.**
ALVERNIA HIGH SCHOOL, CHICAGO, ILLINOIS.

As a student, parent and faculty stimulator, few school activities can equal Science Open House. Some timid teachers hesitate to try it. They shouldn't. It is hard work, of course, but the effort is more than repaid by the results obtained.

Sister Mary Silva has filled her paper with practical suggestions that those who have already conducted open houses will recognize as the fruit of actual experience.

Other exhibitors will agree that exhibits should be selected for their entertainment value rather than for the instruction of visitors, strange as that may seem at first thought.

●

Science Open House as conducted in many high schools is possibly the most popular entertainment offered in the course of the scholastic year. No program is remembered longer, or evokes more favorable comment. Because of the active participation of the entire student body and the keen interest of the guests, this program may be the most vitalizing of the year.

Though the term Open House is most commonly used to describe this interesting activity, other terms, such as Science Meet, Science Night, and Science Fair, are frequently employed. Any attractive name that will serve to arouse the enthusiasm of those whom the school wishes to influence is appropriate.

If the event is to be a success, it must be carefully planned in advance, even to the minutest detail. The possibilities of a program of this nature are limited only by the imagination of the teachers and students participating, and the extent to which they cooperate. It is most desirable, however, that the teachers be merely sympathetic guides to the students in the selection, organization, and execution of their projects; the burden of the work must rest on the students.

In making preparations it is well for those in charge to bear in mind that the visitors come not to be educated but to be entertained. Hence, the more spectacular the exhibits and demonstrations, the greater will be the enthusiasm and interest shown. If the guests leave the building not knowing the explanation of many of the phenomena they have seen demonstrated, but wondering what the explanation may be, Open House has accomplished a worthwhile task.

One factor contributing to the success and popularity of the Science Open House is that every department of the school may have a very definite part in the program. The necessary publicity calls for news articles in the school publications and in the local papers. The writing of these articles may be an assignment for the class in journalism. Invitations must be sent to parents and friends. This may be a task for the English classes. Suitable posters and slogans, the work of the art classes, are distributed throughout the school and the neighborhood. Direction signs and titles for the exhibits may be made by the mechanical drawing class, if the school has one, or it may be another task for the art classes. If the publicity campaign is effectively carried on, the entire community in which the school functions is made Open House conscious, and lives in happy anticipation of a never-to-be-forgotten program.

When the visitors arrive at the school, they should be met by guides who give the necessary information to those unfamiliar with the building. These guides may be students who have no active part in the exhibits or other entertainment on the program. Members of the commercial arithmetic classes find practical experience in checking the attendance, and in supplying statistics for a complete report of the activity. They take note of the number of guests visiting the various exhibits, of the time they spend at each, and of the number and variety of questions asked. This enables the authorities to decide what type of exhibit is most enjoyed or most beneficial. This information may have a direct influence on the nature of future Open House programs.

To lend variety to the program, it is well to permit all the science classes to participate — the physics, chemistry, biology, home economics, and general science classes. The laboratories of these departments have sufficient equipment, even though it be very simple, for the set-up of exhibits that are thought-provoking as well as entertaining.

In preparation for the work, the teacher of each class participating may offer a list of suggested projects. This list may be small, for it is merely to set the pupils thinking. As the work progresses, the number of projects increases in proportion to the enthusiasm of the group. The students working individually or in groups, select their own projects. They write to industrial firms for suggestions, literature, or illustrative material. Meanwhile they inform themselves thoroughly in regard to every detail of the task they have voluntarily assumed, for each one must be an authority on his own project.

The teachers keep in touch with the students and carefully check the work lest inaccuracies, either in the set-up of the exhibit or in the explanation offered, result. Ralph E. Dunbar in an article entitled "Sci-

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School Gardens

For Applied Science and Victory

• By Marvin M. Brooks
DIRECTOR OF NATURE GARDEN SCIENCE EDUCATION, BOARD OF EDUCATION, NEW YORK CITY.

School gardens are useful and inexpensive outdoor laboratories that require work and time rather than costly apparatus and materials. In them boys and girls find healthful occupation. There they apply the knowledge of science they have obtained in the classroom. They learn, too, how to add to America's supply of foodstuffs.

The writer's experience in planning and supervising garden projects enables him to make this paper a very practical one.

The specimen Study Units and Suggested Programs, which are here given in a slightly abbreviated form, have been recommended to the Board of Education of New York City by Mr. Brooks, who kindly released them for publication here. He retains all other publishing rights.

●

Historical Sketch

The first school garden in New York City was started in 1901 by Mrs. Henry Parsons in a city-owned vacant lot which later became a part of De Witt Clinton Park. The first school garden started by a public school was established in 1908 at P.S. 52, Manhattan. This beautiful garden is located on school grounds and has an area of nearly 5,000 square feet.

One of the outstanding features of our garden instruction is the training of teachers by the Brooklyn Botanic Garden, and the New York Botanical Garden. In 1913, the Brooklyn Botanic Garden opened a garden area for children to develop individual plots. These pupils received garden instruction Saturday mornings and became garden leaders and enthusiasts in the various schools of Brooklyn. To this work, the Brooklyn Botanic Garden added teacher training under the leadership of Dr. C. Stuart Gager, Director, and Miss Ellen Eddy Shaw, Curator of Elementary Instruction.

Today we have 190 school gardens, with paid teachers, maintained for summer instruction. Thirty-six additional gardens are conducted by volunteer instructors. There are 41 Victory Gardens with assigned teachers in junior and senior high schools. Junior home garden projects, conducted under the supervision of Mothers' Clubs aided by volunteer inspectors from the Nature Garden-Science office, this year reached the amazing total of 110,043 projects. Some 338 parents' organizations cooperated in this work. Supplementing the work in school gardens, which covers nine months in the year, are over 550 nature rooms. These nature rooms contain nature material and equipment for teaching all phases of nature study. Some 395 schools have lawns that contain an abundance of shrubbery. Nature trails have been established in many of these lawns and many original and artistic signs indicate to the passersby the names of the various shrubs.

Most schools have a nature curator serving as chairman of Nature Garden Science Education. This person is assisted by an alternate. The total garden area for the city is in excess of 25 acres and probably constitutes the largest system of school gardens in the world.

Types of School Gardens

The development of school gardens in the United States finally resolved itself into three definite systems:

1. Centralized school gardens to which children are transported.
2. Home gardens encouraged by the school authorities functioning in connection with a central greenhouse system and a corps of inspectors visiting the homes.
3. School gardens located on school grounds and used as outdoor classrooms for garden science instruction.

The best example of the centralized school garden is undoubtedly found in the school system of Dearborn, Michigan. Because of the large central tract divided into school assignments, the preparation of soil logically becomes the care of the central office. The distance of this school system farm from the various schools necessitates the use of buses for transportation. This type of plan, by virtue of distance, naturally becomes an extra-curricular activity.

The best known exponent of school home gardening is the Cleveland system in Ohio. This arrangement brings the homes and the school together in outstanding friendly relations. From the standpoint of instruction, the work is largely a matter of cooperation between the enthusiastic parent and child and the interested teacher.

The plan of school gardening in New York City is an outstanding example of the third classification. Each school garden is located within the boundaries of the school yard and is surrounded by a high protective fence.

Programming Garden Laboratories

Pupils are programmed for gardening and science during school hours, the same as is done for other school subjects. The children come properly dressed for garden day, the same as for gym day or music day. Be-

tween the outdoor garden laboratory and the classroom is located a garden tool-house or workroom.

In order to reduce passing between the garden and the classroom the best garden period is found to be the last of the morning or afternoon. Two other good garden periods are the first period of the morning and afternoon. Thus, school gardening falls between the opening and closing hours of the day. In this type of schedule garden science is frequently paired with physical training and a weekly library period. We have physical training, gardening and research reading all tied in the same period of the day. Garden science in New York City is recommended by the writer as a cross-section subject for all classes in the 5th or 6th year. Thus classes obtain spring, summer, fall and winter garden experience, and every pupil in the school receives one year of training in gardening.

Garden Method

School gardening is naturally a basic and supply subject as well as a field of application for other school subjects in the curriculum. It supplies material and experiences for physical training, health education, practical English, and every day uses of arithmetic as well as much history and geography. Children learn how to condition soil and improve gardens, and then apply these in home gardens. The practical science of school gardens includes the life cycles of vegetables, shrubs, garden animals and their part in the balance of nature. Decorative features are an important part of our school gardens.

Physical science has its place in the school garden. The wheelbarrow is a second-class lever. Electric lights may be installed for parents' night. A telephone system between the office and the garden is an important feature.

In conclusion, the practical science applications acquired through personal experience in the intermediate grades greatly increase the ability of the young science student for success in higher grades. In the primary grades, nature study is a natural introduction to school gardening.

Coordinating these suggestions, any school may develop a twelve-year science program.

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CHILDREN'S VICTORY HOME GARDEN UNITS

PREPARED AND SPONSORED BY MARVIN BROOKS

UNIT 1. Introductory Victory Home Garden Project
(For beginners in gardening or children up to eight years of age.)

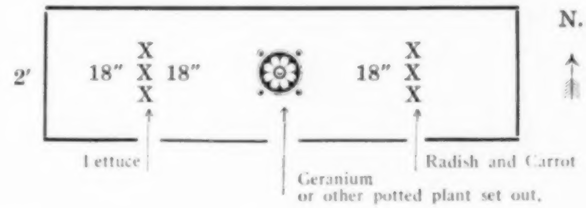
Grow three kinds of plants in window boxes or a small plot. These plants may be vegetables or flowers or both.

Soil Study

1. For the pots to contain plants use this soil formula: garden soil two parts, sand one part, leaf mold one part; mix in a sprinkle of vigoro or similar fertilizer.
2. For the garden plot spade across as deep as possible. Add peat moss and vigoro to the furrow bottom of each row.
3. Repeat in the fall. Grow a cover crop. Have the children explain each step and item.
4. Why cultivate and how. How often?

Information

1. Obtain penny packet seeds (Brooklyn Botanic Garden).
2. Purchase a potted plant (small) from a florist or have mother start one indoors.
3. Address requests for information to MARVIN M. BROOKS, 110 Livingston Street, Brooklyn, N. Y.

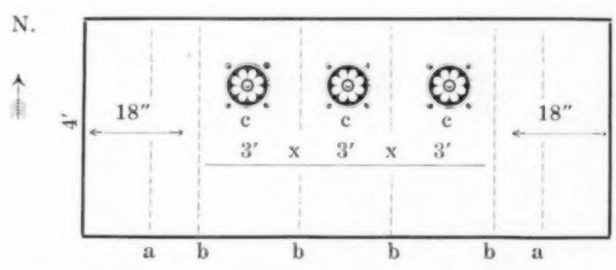


UNIT 2. Elementary Victory Home Garden Project
(For children between 8 and 11 years.)

Plant a plot of six rows each 4' long and 3' apart. The first rows should be radishes and the other five rows should be peas or beans. If the garden is planted in April, plant early peas for cool weather. If the garden is planted in May plant beans for string-beans. Between rows 1 and 2 set in one tomato plant. Between rows 2 and 3 set in one tomato plant. Between rows 3 and 4 set in one tomato plant. Plant tomatoes after May 10th.

Soil Study

1. Follow the directions for Unit 1.
2. Beans and peas are legumes. The bacteria living in their roots add nitrogen to the soil.
3. Nitrogen increases leaf growth, makes leaves tender and a better green.
4. How may this unit become a part of a crop rotation?



(a) Radishes (b) Peas or beans (c) Tomato plants

UNIT 3. Standard Victory Home Garden Project
(For children 11 to 14 years having some previous experience in gardening.)

Grow a row each of (a) sweet allysum, (b) carrots and radishes mixed, (c) beets, (d) Swiss chard, (e) lettuce, (f) beans, (g) dwarf French marigolds. Mix

the carrot and radish seed by planting them in the same row. Radishes grow very quickly and help the slow growing carrots.

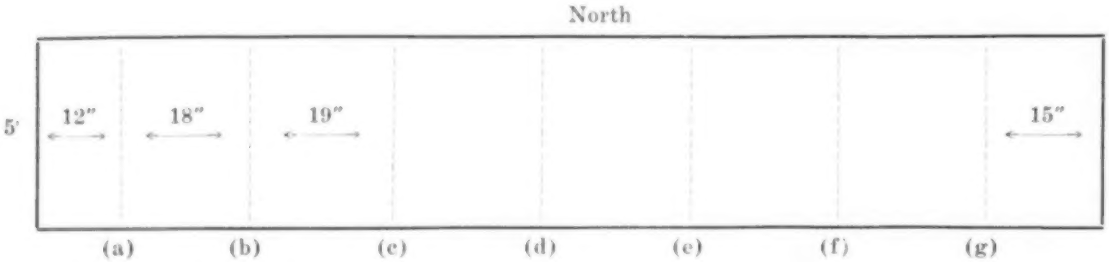
Soil Study

1. Why do we not water after cultivating?
2. Of what does humus consist?
3. How does it act like a sponge in the soil? Is this good for the plant?
4. Be sure you review soil study for Units 1 and 2.

Requisites: A garden plot at HOME and a plot in a nearby SCHOOL garden to be cared for six months or more.

Mechanical: Seed bed preparation, sowing seed, transplanting, watering, cultivating, mulching, drainage, erosion.

Physical: Sand; clay; humus control; moisture activity; soil texture; air, moisture and bacteria control;



NOTE: The small letters indicate the vegetables as given above.

UNIT 4. Advanced Victory Home Garden Project
(For children over 14 years having experience and aptitude.)

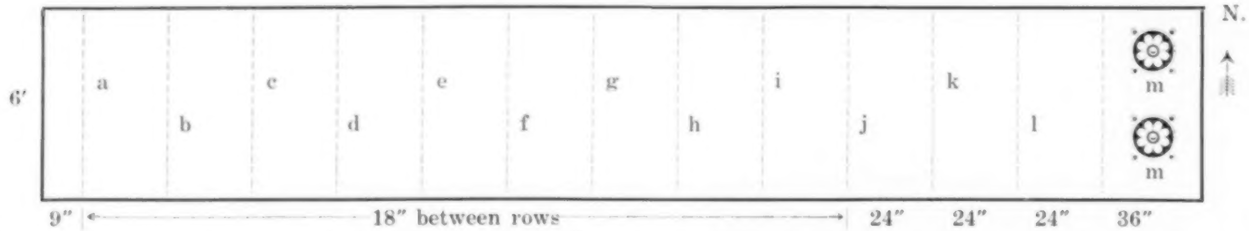
Grow a row each of (a) sweet allysum, (b) carrots and radishes mixed, (c) beets, (d) Swiss chard, (e) lettuce, (f) beans, (g) dwarf French marigolds, (h) kohlrabi, (i) onions from sets, (j) potatoes from cut seed potatoes, (k) zinnias, (l) two rows of golden bantam corn, (m) two tomato plants. Plant rows 18" or more apart as needed and each 6' long. Investigate and try some succession cropping where possible. Visit your local garden supply store for supplies. Tie tomato plants to stakes.

root penetration; ground cover; compost heap; legumes.

Chemical: Plant feeding as to when, how, what; effect of each important chemical on plant growth; insecticides, fungicides, chemical action of root hairs, compost heap.

Directions

1. Exhibit one of the following at the summer flower show: (a) samples of soil, (b) vegetables grown, (c) flowers grown.
2. Exhibit a diary by the week, emphasizing soil improvement.



NOTE:—This garden will be about 25' long. By making this garden 12' long there may be seven rows. Put the seven vegetables in the right to the north where doubling rows in length.

Soil Study

1. See units 1, 2, 3.
2. Why spade in rotted manure or peat moss in the bottom of each furrow when preparing the seed bed?
3. Why sprinkle and rake in each month a very light application of vigoro or other fertilizer between rows not touching plants?
4. Why is cultivating better than watering?

UNIT 5. For Garden Leaders: Soil Conservation; Building and Care; Erosion.
(For children over 12 years having experience, aptitude, and a desire to specialize.)

3. Or write an essay on "Erosion," including hillsides and how to plant there. Illustrate.

Soil Study

1. How does water move in the soil? What type do plants use? How may we control water in the soil?
2. How may we control air in the soil? Why must air be in the soil?
3. How may we control beneficial bacteria in the soil? What do they do?
4. How may we control root growth in the soil?
5. List ways of controlling erosion throughout the year.
6. See Units 1, 2, 3, 4, 5.

SUGGESTIONS FOR A SCHOOL PROGRAM OF CHILDREN'S VICTORY HOME GARDEN PROJECTS

General Suggestions

1. All students conducting *Victory Home Garden Projects* should attend the classes in the nearest school garden for instruction and practice. Principals will supply the time and school. They should join the School Garden Club at that school.
2. All school faculties should attempt to make use of two or more of these *Victory Home Garden Projects.*
3. The principal or nature curator or a specially designated committee should refer this program to the P.T.A. or Mothers' Club of the school for initiation and management.
4. The school should sponsor this program by frequently consulting with the Parents' Club committee in charge.
5. The projects should be selected according to local conditions.
6. Committees of the Parents' Club should inspect garden projects monthly.
7. Children and their parents should furnish all tools and seeds.
8. This program may be also administered by any type of committee the principal of the school may desire to establish.

Records

1. The committee responsible should keep a record of names, addresses and ages of the children undertaking each project and their parents' consent. Keep a separate book for each unit. "Enter" award given, if successful.

Certificates

1. Children completing Unit One, "*Introductory Victory Home Garden Project*" should be commended in a school assembly during September by the Mothers' Club.
2. Children completing Unit Two, "*Elementary Victory Home Garden Project*" in September, should receive a mimeographed letter of commendation signed by the Mothers' Club president, and the school principal (use a stamp).
3. Children completing Unit Three, "*Standard Victory Home Garden Project*" in September, should be awarded by the Mothers' Club the certificate of the School Garden Association which may be purchased for about 2¢ each at 121 East 51st Street, Manhattan.
4. Pupils in grades 7A through 8B, in Junior and in Senior High Schools, completing Units Four or Five, "*Advanced Victory Home Garden Project*" or "*Good Will Victory Project for the Distribution of Garden Seedlings*" should be awarded the certificate of the School Garden Association and the bronze garden pin of that association by the P.T.A. These may be purchased for a very small amount.
5. Pupils, who completed Unit Five, "*For Garden Leaders: Soil Conservation; Building and Care; Erosion*" should be registered with Mr. Brooks who will award them the certificate of the Nature Garden Office and recommend them to the Newtown High School Course in Agriculture or the State Institute at Farmingdale. ●

Photoelectric Phenomena

Continued from Page Seventy-six

other. When a person passes through the path of light on one side of the door, the relay closes, thus operating a motor which opens the door. After passing through the opening, the person passes through the path of light of the second set-up, which operates a motor to close the door.

A very novel use for the photoelectric cell is an application in one of Ohio's larger high schools. Every class room has a photoelectric cell and controls for automatically providing the proper illumination of the rooms. When the natural illumination of sunlight changes, the cell is energized and the artificial illumination begins to operate so as to give even and proper lighting to all parts of the class room.

The most common use of the photoelectric cell is the "talking motion picture." Alongside of the picture on the film is a sound track. Light passes through the blackened area of the track into the photocell. This blackened area is of different intensities to give pulsations of current in the photocell. The current is amplified and used to operate the loud speakers on the stage in back of the projection screen.

Photocell devices are also used on sorting machines. The apparatus is so set up that it will automatically throw off defective material from the conveyor.

The laziest use of a photoelectric cell is illustrated in one of Chicago's larger cinemas. The valve of a drinking fountain is controlled by means of a photoelectric cell, the light source being on one side of the top of the fountain and the relay on the reverse side, so that when the path of light is intercepted by a person's head over the fountain, the relay operates the valve, thus giving just the proper flow of water for the arid customer.

Some of the above applications of photoelectric cells can be illustrated with the demonstration apparatus. Teachers and students may devise other interesting experiments. ●

Photograph by Robert Turrill Hance

NEW BOOKS

Biology for High Schools

• *By* SISTER M. DAFROSE, O. P., Ph.D. P. J. Kenedy & Sons, New York, N. Y. 1942. 797 pp. $2.40.

This textbook has been prepared for Catholic students, and as the author states "Stress is placed on the fact that God has created everything for the use of man, to assist him in working out his eternal destiny, the attainment of happiness with God in Heaven." This book is one of the most interesting and thorough I have examined. It is illustrated abundantly and with fine imagination. The many portraits of past and living biologists help to enliven the spirit of the text, although some of the latter are not going to like the likenesses that have been selected. Many references are made to the contributions of Catholic workers. The lesson plans and examination suggestions will be helpful to the instructors using this new book. *R.T.H.*

Modern-Life Science

• *By* ROBERT H. CARLETON, Summit High School, Summit, N. J., and HARRY H. WILLIAMS, Horace Mann School for Boys, New York City. J. B. Lippincott Company, Chicago. 1942. x + 650 pp. $2.40.

This is not a textbook of general science of the kind commonly used in the ninth grade. It is something different, a textbook of physical science designed for better human adjustment, a new kind of book in a new field, one that should earn for its authors the gratitude of the many senior high school students of non-academic interests, and even of limited ability, who do not plan to enter college. Such students should not be made to study the difficult theories and the multitude of details concerning physics and chemistry that are necessary in the college preparatory course. They are interested rather in a functional science, in scientific knowledge that will be of value to them later in their non-specialized activities as citizens. This new textbook, cutting across the boundaries of the specialized sciences is planned especially for this large but long neglected student group. At last they may study practical everyday science at a near-adult level.

All the carefully selected material has been tried out in the classroom before publication. It is scientifically accurate, clearly described and explained, and well organized into eight large units, which are subdivided into problems. The units are headed: Fire, Fuels and Heat; Power and Machines; The Sky; Weather and Climate; The Crust of the Earth; Materials for Construction; Light and Radiations; and Sound.

Even though they may not be able to introduce a new course immediately, readers of *The Science Counselor* will be interested to examine this book which exemplifies so well the ideas of Professor Carleton who wrote the series of articles on "Physical Science for General Education" which appeared in this journal in March, June and September, 1941. They will not be disappointed. The authors have done well what they set out to do. They have done it so successfully that father and mother, too, will become interested in the new things in science when this book comes home from school. *H.C.M.*

The Conquest of Bacteria

• *By* F. SHERWOOD TAYLOR. The Philosophical Library and Alliance Book Corporation. New York, N. Y. 1942. 175 pp. $2.00.

In these days when the simplification of useful information seems to call for an "isn't science wonderful?" type of writing, it is a relief to find an author who can set down his story interestingly and intelligibly without writing down to his readers. The *Conquest of Bacteria* is a short book that will not insult the intelligence of the most sophisticated reader and yet will be understood by the casual browser. The subtitle "From Salvarsan to Sulphopyridine" abstracts the account of man's search for specific drugs to rid his body of disease-producing organisms. The theory of the action of these modern medicines is clearly presented. This book is a "must" for all students not specially trained in bacteriology, and well worth while to general readers. *R.T.H.*

The Science in Modern Life Series

• *By* VICTOR C. SMITH, Ramsey Junior High School, Minneapolis; GILBERT H. TRAFTON, State Teachers College, Mankato, Minnesota; in consultation with W. R. TEETERS, St. Louis Public Schools. J. B. Lippincott Company, Chicago, 1942.

Exploring Science, xii + 458 pp. $1.32.
Enjoying Science, xii + pp. $1.52.
Using Science, xiii + 802 pp. $1.80.

Here are three attractive, new, general science textbooks that deserve careful examination and serious consideration wherever a change in texts is contemplated. The reviewer believes they will be widely adopted. The books may be used singly or in series. Written by men who either teach or have taught the material they write about, and in consultation with W. R. Teeters, the able supervisor of physical and biological sciences in the St. Louis public schools, these books stand out among competing texts.

The style is simple and clear. Pains have been taken to adjust the vocabulary to insure ready comprehension. Difficult words are defined and pronounced. The material presented has been well sifted, carefully tested, and divided among the books according to difficulty. This grade placement appears to be especially well done. The demonstrations suggested are not too difficult to perform easily, and in general they require but little apparatus.

The pupil as well as the teacher will like the many study aids. Science Activities for Fun, Things to Think About, Exercises in Thinking, Things to Explain, Good Books to Read, General Reviews, and other helps are found at the ends of Units, and Daily Test Exercises at the ends of Problems. Teachers' Manuals and Separate Unit Tests are available.

The books are strongly made, well printed, and copiously illustrated. *H.C.M.*

Portraits of Famous Physicists

• With biographical accounts by HENRY CREW. Scripta Mathematica, New York, N. Y. 1942. $3.75.

Every college and high school department of physics should have this new portfolio of portraits; for framing, perhaps; for binding; as a teaching device; and for reference. The best available portraits of Galileo, Newton, Huygens, Ampere, Fresnel, Rowland, Faraday, Joule, Clausius, Hertz, Gibbs, and Maxwell have been selected and each is inclosed in a folder containing an 800 word biography written by Henry Crew of Northwestern University. The portfolio of portraits is limited to twelve physicists who were no longer living in 1937, and the names of those to be included were chosen by a committee of scientists named by the editor of the publication now known as the *American Journal of Physics*.

The typographical work is beautifully done. Properly framed these portraits will grace any library or lecture room. *H.C.M.*

College Physics

• *By* WILLIAM T. MCNIFF, Fordham University Press, New York City. 3rd Edition. 1942. 639 pp. $4.00.

In this text the two volumes of the preceding editions have been combined. Commendable features of the new edition are, first, a final chapter of 38 pages on some of the outstanding advances of modern physics; and second, two chapters which describe certain applications of physics to biology.

One of the two chapters on biological applications, entitled, "Physiological and Therapeutical Effects of Change in Air Density," is a worth-while addition to the usual material of physics texts. The other chapter, entitled, "Electricity as a Therapeutic Agent," is very brief. While it is interesting, it unfortunately gives the impression that the various beneficial effects attributed to electrical treatments of one kind or another are generally accepted facts, which is not the case.

Some parts of the book are well written, but too many important topics are presented in a brief and superficial manner. For example, the kinetic theory of gases is dismissed with 7 lines. Occasional inaccuracy of statement is encountered and some figures are not well drawn. An example of the latter is the poor drawing of the mechanism of the human ear. The number of figures is smaller than the average number in other well known texts. *G.E.D.*

COMING . . .

In Future Numbers

The Hierarchy of the Sciences

By REVEREND EDMUND J. HAMEL, S.S.E., Department of Philosophy, Mt. Michael's College, Winooski Park, Vermont.

Pre-Flight Courses for Secondary Schools

By ROBERT HAMBROOK, Senior Specialist, Trade and Industrial Education, United States Office of Education, Washington, D. C.

Colchicine-Induced Polyploidy in the Fruit Fly

By D. C. BRAUNGART and G. E. OTT, Department of Biology, The Catholic University of America, Washington, D. C.

Science News Reporting in America

By GOBIND BEHARI LAL, Science Editor, International News Service, New York City.

Frequency Modulation

By DWIGHT A. MEYER, Chief Engineer, Radio Station KDKA, Pittsburgh, Pa.

Graduate Students in Agricultural Science

By E. M. HILDEBRAND, Agricultural Experiment Station, Cornell University, Ithaca, N. Y.

The Electric Refrigerator as a Summarizing Experiment in Heat

By HENRY W. KNERR, Department of Physics, Pennsylvania State College, State College, Pa.

School Housekeeping and School Success

By MARY W. MULDOON, Principal, Junior High School, Waverly, N. Y.

Metallic Lead Products

By F. E. WORMSER, Secretary, Lead Industries Association, New York City.

The Department Head and the Classroom Teacher in Secondary-School Science Supervision

By FRANKLIN T. MATHEWSON, Public High School, White Plains, N. Y.

Fiberglas

By WILLIAM H. PAGE, Bureau of Industrial Service, Inc., New York City.

Transcriptions in Education

Continued from Page Sixty-nine

Through the cooperation of the Carnegie Corporation, a "talking book" project for the blind has been established under the auspices of the American Foundation for the Blind. Most of the items listed were recorded originally for the Library of Congress and are now available on a loan basis to the blind through libraries in communities everywhere. NBC has cooperated in supplying transcriptions of many of the outstanding speeches made in recent times by Winston Churchill, President Roosevelt, and other leading statesmen of the day.

Yet another experiment has been conducted by the Committee on Scientific Aids to Learning in which 40 recordings in general science for the seventh grade level were used as the basis for a study involving 307 classes and nearly 11,000 pupils distributed among fourteen states. The purpose of the project was to discover the relative effectiveness of the radio broadcast as compared with the recorded program as a teaching aid in science. Seventy-one per cent of the teachers reported much attention on the part of the pupils who heard the recordings only: 21 per cent reported some interest. Many of the children reported that they were interested in the records because "it was like having another teacher", to use their own words. Children often asked to have records they liked repeated. Their statements indicated a genuine approval in the use of records.

Harold W. Oxley, Director of C.C.C. Education, reports that approximately 40 per cent of the camps have organized listening groups, and about ten per cent have special classrooms for such groups, all of them using recordings as a basic teaching aid. Recordings have been used experimentally in citizenship courses, and results indicate that these records are valuable aids in creating interest in the course and in shaping attitudes.

The U.S.O. in all of its branches throughout the nation have instituted plans for the use of recordings in army camps and naval bases. Playback machines have been installed in nearly all U.S.O. Clubs which are being used at present primarily to record letters for the soldiers' families at home, but which will eventually be used for the reproduction of recorded radio programs and other transcribed material especially made for that purpose by the morale divisions of the Army and Navy and other agencies.

And in yet another field, recordings are becoming a significant factor in the religious groups. The National Conference of Christians and Jews reports that the Catholic Church has been particularly active in the use of transcriptions. In this instance, the records are not intended for classroom use specifically. They are produced for use as "spot" broadcasts by local stations. One program has been used as a recorded feature on 110 stations weekly; another, also recorded, has been used on 115 stations weekly; and a series of six recorded dramatizations for Holy Week was heard in 1941 on a total of 239 stations. As yet, we have no experience available in the use of records for listening groups in church schools, and here again we have a field that offers rich opportunities for the study or discussion of the great stories of the Bible and the special problems of religion.

The Evaluation of School Broadcasts project at Ohio State University has given us, after extensive study, a basis for selecting appropriate recorded material. According to these recommendations, the program must influence the understandings, attitudes, and appreciation of its listeners; it must appeal to interest and attention values characteristic of the type of listener for whom the program is intended; and it must be comprehensible and clear according to mechanical standards in manufacture and reproduction.

Other factors have been suggested by Professors Seerley Reid and Norman Woelfel of Ohio State University. According to these experts, we must judge the value of our records in terms of maturity level, length of program, leading ideas, social significance, historical perspective, integration of learnings, cultural understanding, uniqueness of presentation, democratic values, accuracy and validity.

From several surveys in recent years, we can conclude that programs selected for recording must fulfill specific classroom standards in reference to grade and age level, factual information, concise presentation, vocabulary, production techniques, and mechanical factors in clearness, and volume, and frequency range.

The selection of recordings without benefit of pretesting is of little or no value. No teacher would choose a textbook at random, nor would she accept the advice of any but a recognized authority. It is obviously impossible to permit pretesting of records by every prospective purchaser, but at NBC we hope to submit each record offered for sale to a qualified board of judges, including representatives of universities and colleges which have been engaged in studies in this field, and teachers and administrators from city school systems already using recordings as teaching aids. It may eventually become possible to test each record in actual classroom situations before it is available to the public at large.

The National Broadcasting Company has in the past three years conducted three studies of special interest in the classroom use of records. These experiments have been done with the cooperation of the public schools of Philadelphia, Elizabeth (New Jersey), and Greenwich (Connecticut).

In the Philadelphia report, it is clearly indicated that adequate reproduction or playback machines are essential. It is also evident that improper use of the equipment will result in a negative response from the students. When the equipment is placed in control of students who are not mechanically inclined, the repro-

duction is almost invariably deficient. If the playback machines are of the cheaper varieties, insufficient volume is available to enable all of the students in a large group to hear the program clearly.

Retention values in Philadelphia were especially significant. In recall tests given one week after the record was heard, students proved the retention of more than 80 per cent of the factual information included in the program. Recordings in the literature and social science fields were found to be particularly effective, and values were discovered in stimulating further interest in vocal expression and literary appreciation.

In Elizabeth, New Jersey, both teachers and students reported favorably on the use of records, and the same was true in the schools of Greenwich. But in every instance, certain factors appeared in bold face: one, the teacher must pre-test the recording herself before playing it in class; two, the recording must be correlated with class activities through preliminary and follow-up discussions and through out-of-class assignments based on the material contained in the record; and three, the recording should never be used as a substitute teacher or as an escape from classroom routine, but rather it must be adapted to the needs of the course and of the lesson for the day.

The use of proper playback equipment, sufficient in volume response and frequency range, cannot be overemphasized. The purchase of a cheap playback machine will bring only the most discouraging results. A suitable playback machine must afford volume sufficient for a class of at least sixty to one hundred students. It must reproduce both speech and music accurately and without distortion or muffling. It must be properly counterbalanced or the undue pressure on the records in playing will result in rapid deterioration of the discs. It must be conveniently portable and simple in operation. It must be able to accommodate a sixteen inch disc, and it should preferably be a two speed machine, capable of reproducing both the slow speed or 33⅓ RPM transcription, and the high speed or 78 RPM phonograph record.

Recent government restrictions on certain materials will, of course, seriously retard the development of the recording as a classroom device. Latest information is that playback machines are not now available for purchase except in isolated instances, but these restrictions may be relaxed. However, it must be remembered that more than three thousand high schools in America are already equipped.

There are also the restrictions on the materials used in records, and the recent announcement of a seventy per cent cut in the manufacture of phonograph records for home use. However, recording engineers have been working for some time on suitable substitutes for the

aluminum and other essential war materials used in discs. We are told that present restrictions on phonograph records will not for the time interfere with the manufacture of the low speed, sixteen inch discs. Records have been made of glass with satisfactory results where reproduction was concerned, but the glass disc will break, and particularly in the handling of discs by students, the glass type will prove altogether too fragile for school use. Other discs recently used have been made of fibre compositions, and tests indicate that the fibre disc will be more acceptable as a substitute for the former acetate type.

It is assumed that the cost of these recordings will be reduced to a minimum within the budget of almost every school, but this will come only when sales reach a suitable volume. The greatest extension of the use of records will occur in the development of the rotating or lending library plan. Several institutions and state-departments of education have already established central lending libraries. The records are purchased by the central authority concerned, and loaned to the schools of a given area for a small rental fee, perhaps 25 or 50 cents.

The subject matter to be included in the NBC recording service will at first be confined to broadcasts which have actually been presented on the air, such as The World Is Yours, University of Chicago Roundtable, Art for Your Sake, Unlimited Horizons, Doctors at Work, Speaking of Liberty, and others regularly heard on the NBC network. Later it is hoped that we shall be able to record material especially prepared for that purpose, and graded for specific levels in the school system. It is conceivable that eventually any given program in our catalogs will be available, for example, at the 4 to 6 grade level, the 7 to 8 grade, the 9 to 10, and the 11th grade through the university.

In other words, any given program may be available in five or six different forms, especially written and produced in terms of vocabulary and approach for the intelligence levels of students in all grades, elementary through the university.

Our plans for the establishment of the recording service have been subject to many delays and unforseen difficulties. Latest delays have been caused by recent readjustments in the fundamental operations of the radio networks, and uncertainties concerning the availability of war materials. However, we are proceeding, and in the face of the great interest aroused by recent announcements, we can only ask that our friends be patient and assure themselves that further announcements will be made as quickly as possible. The recording will provide a tremendous impetus for the development of the entire audi-visual education field. No one can forsee the possibilities in the future, but

with a combination of film slides and records, or of new types of recordings on tape, or combinations of several elements already on the horizon in audi-visual education, an entirely new approach to teaching in the classroom will be ready at hand for the instructor of tomorrow.

Whatever the war may bring in further delays, the recording has proved itself as a motivator in education. It stimulates intellectual curiosity. It vitalizes formal education. It cuts through the out-moded packaging of education and serves to show the relationships in life and in all fields of knowledge. In short, the recording and its associated aids will mean the appearance of a new and dynamic type of education with the world of radio ready for the guidance and inspiration of every student in schools and colleges, large and small. ●

Chromosomes

Continued from Page Seventy-four

separating daughter chromosomes. These are called *interzonal fibers.* The interzonal fibers persist into telophase when they come together in the central axis of the spindle and form what is known as the *Stem body.* According to some observers the stem-body exerts a thrust which further separates the daughter telophase nuclei.

The spindle as above described is known as the amphiastral spindle and is found in most animal cells. The spindle of a dividing plant cell lacks the asters (centrioles and astral rays) and has a barrel shaped or anastral spindle. It also lacks the interzonal fibers and the stem-body. The continuous spindle fibers of the plant spindle persist during telophase in the region of the equator where they are gradually spread out towards the cell wall by the developing cell plate (the new cell wall). This spreading spindle remnant is called the *phragmoplast.* Another spindle structure peculiar to plant cells is the *polar cap.* Polar caps are formed of fibrillar spindle substance in prophase before the disappearance of the nuclear membrane. They extend from opposite sides of the nucleus towards the poles, and as the nuclear membrane disappears they enlarge and form the entire spindle.

Recent cytological literature contains many interesting cases of modifications of nearly all the points of chromosome and spindle structure summarized in this paper. It is impossible to treat of these special cases here but cytologists hope by the study of these exceptional cases to throw more light on problems of the normal behavior of the chromosomes in mitosis. ●

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Science Open House

Continued from Page Seventy-nine

ence Open House" in the March, 1939, issue of *The School Executive* says: "The testing of milk by the Babcock test is not a difficult task for a High School student. However, should the milk tested be obtained from a sample after the cream has been poured off for coffee a very low butter-fat content would be shown. If this is reported the dairy which supplied the milk would of course be unjustly criticized. Similar situations may arise in connection with the testing of coal, gas, and other articles. Therefore, careful checking of the students' results is essential."

Students have hobbies which consume much of their after-school time. Open House affords them an excellent opportunity to display the results of their productive leisure hours. One might mention camera club activities, marionette making, stamp collecting, soap carving, and a host of other interests that are characteristic of boys and girls of high school age.

The value of such a program carried out as herein indicated cannot be overestimated. The benefits that accrue to the students are manifold. By no means the least desirable of these benefits is the satisfaction that comes to the student from having accomplished a worthwhile piece of work. School means more to him now possibly than ever before, and he enters upon further tasks with a zest truly remarkable.

Another type of Open House program partakes of the nature of a Science Fair. In the auditorium, gymnasium, or some other suitable room, booths are constructed and the exhibits are displayed therein. The place may be artistically decorated in the school colors, and the booths made attractive by an orderly arrangement and careful color selection. To preserve the memory of the event, pictures of the booths may be taken before the visitors are admitted, for the booths will never have as attractive an appearance after the Fair as before. When the doors are thrown open, each exhibitor must be present to explain his display.

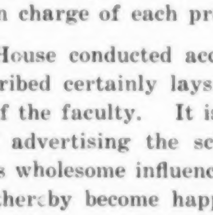
To induce the students to do their best, it is well that the teachers evaluate the exhibits. In this evaluation the following points may be considered: orderly arrangement, the time required in executing the project, originality of the idea, artistic value, clearness of explanation, effectiveness of the display, and the value to the individual and to the public. A grade of *perfect* may be given if the project is successfully completed. Successful completion implies the proper dismantling of the booth and the return of all borrowed material; "after-dependability," as Rev. Daniel Lord, S. J. suggests, must be stressed in order that the full educational value may be derived. Though gratitude must be expressed to any industrial houses that supply material or information, under no condition should the name of any firm be mentioned, nor may it appear at any of the exhibits. The Science Fair is not an advertising agency; rather, it is a function of the science departments of the school, and it must be maintained as such.

A third method of conducting Science Open House suggests that the program partake of the nature of an intramural or interscholastic contest. The participating classes or schools choose their teams according to a plan agreed upon and secure the services of impartial judges. After the contest, the laboratories are opened, and the remainder of the program is much the same as indicated above.

Another method of conducting such a program is to carry out the entire schedule of the school day in the presence of guests. This is, of course, not strictly Science Open House, but stress may be put on the work of the science classes by way of exhibits of pupils' work, demonstrations, and the execution of class projects. The method is much less spectacular than those previously explained, but it does allow the parents and friends to see those in whom they are interested in the actual environment of the classroom. It has given much satisfaction in many schools.

Ralph E. Dunbar, in an article mentioned before in this paper, suggests the following: "A typical Open House Program may consist of three main parts. About 1:30 P. M. an excursion may be made to several industrial plants of the city. This plan works well for small groups but where the group becomes too large and unwieldy some schools have been forced to discontinue this practice, or to conduct several tours simultaneously. About 7:30 P. M. a general mass meeting may be held, at which time scientific movies may be shown and a speaker of national reputation may address the assembly on some recent scientific development. Following this part of the program laboratories are thrown open and the general exhibits are explained by the students in charge of each project."

Science Open House conducted according to any of the methods described certainly lays an extra burden on the members of the faculty. It is, however, a very effective way of advertising the school and thereby bringing under its wholesome influence energetic young people who will thereby become happier, more intelligent, and better citizens and more faithful servants of God, the Author of all science. Such a program must produce beneficial and far-reaching results for all concerned. ●



Wetter Water

Continued from Page Seventy-eight

cylinder may seem to be dissolved when vigorously stirred, but when the action ceases, two distinct layers again form.

One of the practical applications of this wetting action is in the textile industry. Cloth is washed before dyeing and the soap, because it does not dissolve in water, collects in lumps on the cloth. The dyeing, therefore, is not even. This costly production waste is eliminated by the use of a wetting agent.

A practical wetting agent has a high resistance to hard water. It facilitates the production of a lather speedily and with much satisfaction.

To show the effectiveness of a wetting agent in even extremely hard water, this experiment can be performed. Two bottles, each containing 200 c.c. of distilled water and 5 c.c. of a soap solution, are used. When the bottles containing the liquids are shaken, a permanent lather is produced in each. To one of the bottles add 1 c.c. of hard water (made by adding 14.25 grams of calcium sulfate and 8.70 grams of magnesium sulfate to a liter of tap water). The suds disappear and a definite curd is formed. This solution is reversed when the wetting agent is added (90 c.c. of a 2% solution of Novonacco).

Not all wetting agents have the same power of wetting. To determine their strength, the Draves test is used. This test is based upon the speed with which the agent wets in various solutions. Since we are concerned with water, an application of the Draves test can be performed to demonstrate its principle. To show the relative strength of two different wetting agents, three cylinders, each containing over a liter of water, are used. A piece of non-absorbent cotton is floated on the surface of each. To the first cylinder one agent (50 c.c. of a 2% solution of Novonacco) is added, while the second cylinder receives the other agent (20 c.c. of a solution of Aerosol OT‡ prepared by using 1 c.c. of a 25% solution in 10 c.c. of water). The cotton sinks more rapidly in the second cylinder (Aerosol OT) than in the first (Novonacco), thus showing that the agent used in the first cylinder is the more powerful wetting agent. The third cylinder is the control.

A wetting agent does not exercise its power on inanimate objects only, but extends it even to living things. A duck, like the non-absorbent cotton, finds it impossible to swim in wetter water! The unsuspecting

‡Aerosol OT is the product of the American Cyanamid Company.

animal is allowed to float in an aquarium containing approximately ninety-five liters of water. The wetting agent (160 c.c. of a 25% solution of Aerosol OT) is added slowly to the water's surface around the duck. The penetration of the oil on the duck's feathers,—the factor which keeps it afloat,—begins immediately upon introduction of the agent to the water. Within a few seconds (20-30) the duck slowly starts to submerge. Struggling to keep afloat only speeds the sinking for the wetter water is thus brought into contact with more body surface.

The splashing, frantic animal would drown if not rescued in time! The duck is removed from the water, soaked to the skin. On drying, the feathers return to their natural state and the duck can swim again, but not in wetter water! ●

Collecting Butterflies

Continued from Page Seventy-seven

determined by the structure of the external genitalia. More work and research must be done in the other groups of butterflies if we are to discover other morphological structures which can be used as an aid in determining species. For those biologists who enjoy microscopical work and the preparation of slides, this field offers a challenge with a more or less definite promise of satisfactory results. The anatomical studies of this group should be carried ever further and swing into histology, which has been sadly neglected.

The field zoologist can also apply his scientific knowledge. Ecological studies of this group can involve fascinating work in the field. Each species or genus exhibits certain characteristics which add to its interest. Some species are found flying in the open fields, others around swamps. Many are sylvan in habit. In numerous cases, the environment coincides with the habitat of the specific foodplant on which the larvae feed. It is also interesting to watch the females laying their eggs, the method of ovipositing, the shape of the egg, and the food plant of that insect. Larval forms can be studied and reared to adults. The life-histories of only a small percentage of the North American butterflies have been described, and notes on the various instars are of definite scientific value.

Butterflies are also of importance to the economic entomologist. The ravages of the caterpillar of the cabbage butterfly (Pieris rapae) are well known, and the study of their habits and control is of great help to the farmer. On the beneficial side, the larvae of the Wanderer (Fenesecka tarquinius) feed upon plant-lice which are harmful. The usefulness of butterflies in pollination remains to be determined more completely.

Finally, the entomologist who enjoys collecting can describe regional faunas with reference to the number of species found in a given locality, their time of flight, and the number of broods occurring during the year. William Field's *A Manual of the Butterflies of Kansas* is an excellent example of this type of work. It is a definite contribution to the complex jig-saw puzzle of the distribution of lepidoptera. For those collectors who like to travel, there are numerous regions which still remain to be collected, and every embryonic lepidopterist has the opportunity to discover a new species or race of butterfly. The author of this paper has described eight new species collected by Mr. Jack May in the Riding Mountains of Manitoba, a region that had never been collected before. Parts of Nevada, Wyoming, northern Maine, and huge portions of Canada have been collected only in isolated regions. With the improvement of traveling facilities into these regions, collectors will extend their frontiers, and the fortunate ones to collect in these regions will unquestionably discover new species. They will also obtain important data on the distribution of already known lepidoptera.

There are, of course, those who are merely interested in moths or butterflies for their own sake without thought of any practical application of their knowledge. They want to know more about their anatomy, both gross and microscopic, they want to learn more of their special adaptations for fitting into their surroundings, and of their habits of life. Others again are interested in forms that bring economic loss or gain to man. The study of color production and of color pat-

terns in lepidoptera may yield information on similar chemical activities in man where we find hair turning white with age and abnormal pigment development in melanotic tumors, moles, and skin discolorations. Understanding of what is taking place in these pathological growths or reactions may well lead to their eventual control.

A few suggestions as to the possibilities of research in this field have been presented here as an answer to the gentleman on the brown mare, and as a challenge to those butterfly collectors who have started on the road of science.

I hope that this article will not only indicate to lepidopterists that endless possibilities in research exist, but also that it will help biologists to realize that the science of life offers a never-ending challenge to those with open minds who question How and Why. ●

Federal Regulations

Continued from Page Seventy-one

"Under regulations prescribed by the Commissioner with the approval of the Secretary, no tax under this chapter shall be imposed with respect to the sale of any article—(a) for the exclusive use of the United States, any State, Territory of the United States, or any political subdivision of the foregoing, or the District of Columbia." (Sec. 2406).

The phrase "any political subdivision" (of a State) is understood to cover cities, towns, villages, and their tax-supported public school systems.

To establish his right to exemption from tax, the purchaser should send with his order an exemption certificate, signed by a qualified official of the state, city or town for whose exclusive use the purchase is made. In the absence of an exemption certificate, the manufacturers' and retailers' excise taxes must be paid, respectively, by maker or dealer.

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While the foregoing abstracts are thought to conform to the letter and spirit of requirements in effect at this writing, it will be evident that, in time of war, nothing is certain,—except uncertainty. It will likewise be recognized that regulations may be revised, restrictions may be redefined, and privileges may be revoked, without advance notice to maker, dealer or user. ●

A Science Society

Continued from Page Sixty-seven

the supervision of the college concerned. Carnegie Institute of Technology, Pittsburgh, Seton Hill College, Greensburg, and St. Francis College, Loretto, have responded with substantial assistance. The University of Pittsburgh is observing the work of the society and promises aid when conditions seem to warrant it. Scholarships have not yet been received from other colleges that have been contacted, but some of the schools have commended the aims of the organization and wish us success in attaining them.

The Science Committee of the Pittsburgh Diocese hopes to continue to direct into proper channels students who show an aptitude for this branch of learning. The work done this year has had a twofold objective: that of aiding the individual by giving him educational opportunities in the world of science, and, in return, to give to the world a group of embryonic scientists. Here, perhaps, the work of the high school ends, and that of the college begins. ●

Prehistoric Dwellings In The Southwest

Excavation in a Colorado Hillside of a village once inhabited by a mysterious people who lived in the Southwest about the third century A. D. has recently been reported by Carnegie Institution of Washington. These people were a branch of the widespread Basket Makers, who were the earliest ancestors so far identified of the Cliff Dwellers and of the Pueblo Indians of today. They conformed to Basket Maker material culture in every respect but seem to have been of a somewhat different physical stock because their skulls were as short and broad as those of their contemporaries in neighboring localities were long and narrow.

It is the accepted belief that the early Basket Makers camped in the open and never erected permanent dwellings. The chief contribution of the Carnegie excavations, as reported by E. H. Morris, is proof that at least some groups of Basket Makers were building substantial homes for themselves long before they had learned to use the bow and arrow or to make pottery.

The site was found about ten miles north of Durango, Colorado, on a steep, timbered hillside. It was a vaguely defined terrace, the mass of which was composed of earth moved during leveling operations, the wreckage of dwellings, and debris that had accumulated during the operations. The village had consisted of two rows of single-room dwellings.

First, as the picture is reconstructed by Mr. Morris, the hillside was dug into and the earth piled out in front until a level spot of the desired size had been provided. Upon this a wood and mud house was erected. Such dwellings were short-lived, the great majority of them having been destroyed by fire. If the site was to be built upon again, the residue of the conflagration was scooped down the hillside and excavation carried a little farther into the slope at a slightly higher level than before. The fresh earth was spread on the old floor and a new dwelling erected.

The houses were roughly circular and from 9 to 30 feet in diameter. Each floor was saucer-shaped, with a heating pit at the center. Much of the space was taken up by storage bins.

The walls, Mr. Morris' excavations showed, had consisted of wood and mud masonry—logs, poles, twigs and chunks of all sorts—laid horizontally, the interstices filled with mud, and the surfaces chinked after the fashion of log cabins. The roofs must have resembled inverted bowls.

Artifacts gathered at the site consisted of a variety of metates, or stone grinding bowls, hand hammers and choppers, many knife blades and projectile points, a profusion of bone implements, and a few beads and ornaments. There were shreds of coiled basketry and cloth, some burned corn, and some impressions of matting in clay.

The dead were deposited with little care in rude pits gouged into the natural hillside, or into house debris if it was more convenient. ●

American Science Teachers Association To Meet In New York

The next meeting of the American Science Teachers Association, the country's largest association of teachers of science, will be held at the Hotel Pennsylvania, New York City, on Tuesday and Wednesday, December 29 and 30, 1942. The attractive program that has been arranged is published here, far in advance of the convention, so that teachers may plan to be present at the sessions which they judge to be most interesting.

Science instructors in the New York district, and those throughout the country as well, are cordially invited to attend whether they are members of the Association or not. Any teacher of science may become a member by sending the yearly membership fee of $1.00 to the Treasurer, Leo J. Fitzpatrick, Brockton High School, Brockton, Mass. The fee includes a one year's subscription to *The Science Teacher*, the quarterly journal which is the official publication of the Association.

Joint meetings with other science associations of the A.A.A.S. group are being arranged for December 28-29.

PROGRAM

TUESDAY, DECEMBER 29, 1942

Dinner Meeting, Board of Directors .... 6:00 P. M.
Hotel Pennsylvania

Student Science Congress .... Evening
American Museum of Natural History

WEDNESDAY, DECEMBER 30
Hotel Pennsylvania

MORNING

SCIENCE TEACHING IN WAR-TIME

1. As related to Aviation .... Dr. Ralph E. Horton
Chairman, Standing Committee on Science, New York City Schools
2. As related to Nutrition .... M. L. Wilson
Assistant Director in Charge of Nutrition, Office of Defense, Health and Welfare Services, Federal Security Agency, Washington, D. C. Former Under-Secretary of Agriculture.
3. Science Instruction at all levels in relation to the War effort .... Brigadier General Lewis B. Hershey
Director, Selective Service System, Washington, D. C.
4. Experiences in the teaching of special Defense training courses in science .... Dr. Arthur Rose
Pennsylvania State College, Supervisor for Chemistry, E.S.M.D.T., State College, Pa.

NOON

LUNCHEON — *Hotel Pennsylvania*

Dr. Otis W. Caldwell,
General Secretary, A.A.A.S., presiding.

Dr. Arthur H. Compton,
President, A.A.A.S., speaking.

AFTERNOON

CURRICULAR PROBLEMS

1. The sequence of science studies in New York State .... Dr. Warren W. Knox
Director, Division of Secondary Education, New York State, Albany, N. Y.
2. The sequence of social studies .... Prof. Roy W. Hatch
Head of the Department of Social Studies, State Teachers College, Montclair, N. J.
3. Discussion: The implication of sequences for the secondary curriculum as a whole .... Led by Dr. Walter Thurber
Instructor and Critic Teacher in Science, New York State Teachers College, Cortland, N. Y.
and Dr. Philip G. Johnson,
Director of Teacher Training in Science, Cornell University and Ithaca Public Schools, Ithaca, N. Y.
4. The science survey course for college freshmen .... Dr. Benjamin Harrow
Department of Chemistry, College of the City of New York, New York City.

Story of Magnetism

Continued from Page Sixty-six

Very briefly we may say that in some ways the ideas of Rittenhouse foreshadow those published in 1854 by the German physicist Wilhelm Weber. Immediately after Rittenhouse the French physicist Coulomb assumed that each magnetic molecule imprisons equal amounts of boreal and austral magnetic fluids. Magnetizing consists in separating the fluids inside the

molecule. Thirty-five years later Poisson, another Frenchman, developed Coulomb's ideas into an elaborate theory.

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The Third Incident occurred in Pennsylvania, and brings us still deeper into modern times. In 1832, Alexander Dallas Bache was teaching Natural Philosophy in Philadelphia. Professor Bache had been an officer of the Army, a West Pointer. He was a vigorous young man who had learned to fill each minute "with sixty seconds worth of distance run." During the summer vacation of 1832 Professor Bache, assisted by his pupil Mr. John F. Frazer, set up a magnetic observatory in the country to study the "Diurnal Variation of the Horizontal Needle." In the published account[2] the observatory is described as located in a garden "upon the side of a hill, the ground sloping toward a meadow: a hill enclosed this gorge both on the east and the west . . . The latitude of the place, which was about one mile from the village of West Chester, is about 39° 58′, and its longitude about 21 miles west from Philadelphia."

During February, 1941, many institutions and learned bodies joined in recalling and in honoring Alexander Dallas Bache. A historian who was preparing a paper[3] to be read during the celebration, asked that he be guided to the site where Bache and Frazer had set up their observatory during the summer of 1832.

The latitude given, and the statement "about one mile from the village of West Chester" when applied to the West Chester Quadrangle of the U. S. Geological Survey, place the site in the valley of Taylor's Run which flows westward to the north of West Chester. Other bits of evidence suggested the east end of the valley.

The problem was referred to a local historian[4] who advanced the happy suggestion that an old building still standing along Taylor's Run was probably the scene. For it answers the description in all respects and around it hangs a tradition that a century ago it was a favorite meeting place for men of scientific interests.

There is still lacking some bit of contemporary record, such as an item in a local newspaper, an entry in some old diary, a record in the court-house to change a probable solution of the quest into a certainty. Such records have been sought for but have not yet been found.

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The Fourth Incident keeps us in Pennsylvania, and brings us to times just one hundred years ago. Like the Third Incident, it has to do with the Earth as a great magnet, and with a small region in the magnetic field of the earth.

In the published account of the meetings held in Philadelphia during February, 1941, to commemorate the life and work of Alexander Dallas Bache, there appears a beautiful magnetic map of Pennsylvania and contiguous territory for the year 1842, the work of Professor Bache.

In his evening lecture delivered on February 14, 1941, Director J. H. Fleming said[5]

> "The earliest detailed State magnetic survey in North America was made by Bache in 1840 to 1843, namely his 'Magnetic survey of Pennsylvania and parts of adjacent States'. The observations at 22 points were made by Bache during his summer vacations and at private expense."

A desire arose to consult the original of the map and the data from which it had been made. Something in the title of the map gave a clue. It read, "By A. D. Bache, Supdt., U. S. Coast Survey, 1862." The report of the Superintendent of the Coast Survey[6] for 1862 in its appendix No. 19 and Sketch 47 reports "An abstract of results of a magnetic survey of Pennsylvania and parts of adjacent states in 1840 and 1841, with some additional results of 1843 and 1862."

The young professor who spent his summer vacation of 1832 making magnetic observations near West Chester, had continued at such work during his vacations of 1840, 1841, and 1843. In 1843 President Tyler appointed Professor Bache Superintendent of the U. S. Coast Survey, the second man to hold that post of distinction. He filled the post for twenty-four years.

And recently, one hundred years after the years just mentioned, the learned world has paused to devote two days to their memory. ●

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[1] C. M. Dowlin, Polymathean Professors, *American Journal of Physics*, April, 1942.

[2] Transactions of American Philosophical Society, 1837.

[3] E. P. Cheney, The Connection of Alexander Dallas Bache with the University of Pennsylvania, *Proceedings of the American Philosophical Society*, Vol. 84, No. 2.

[4] Henry Pleasants, Jr., M.D.

[5] *Proceedings of the American Philosophical Society*, Vol. 84, No. 2, pages 272-3.

[6] A. D. Bache.